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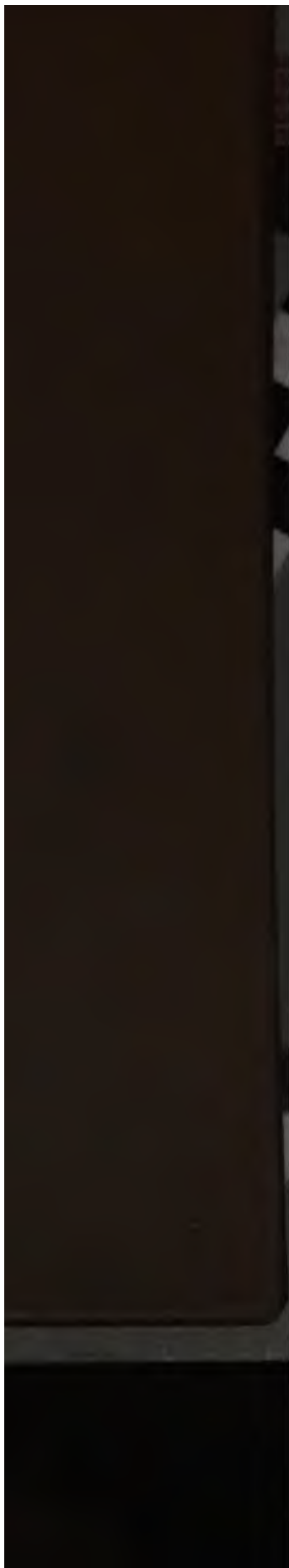
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**GEOLOGICAL**  
**T R A V E L S.**

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BY J. A. DE LUC, F.R.S.

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IN THREE VOLUMES.

— VOL. III. —

NEW YORK  
PUBLIC  
LIBRARY

TRAVELS IN ENGLAND.

TRANSLATED FROM THE FRENCH MANUSCRIPT.

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London:

PRINTED FOR F. C. AND J. RIVINGTON, NO. 62,  
ST. PAUL'S CHURCH YARD.

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1811.

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# TRAVELS

IN

## ENGLAND.



### JOURNEY THROUGH DEVONSHIRE, 'CORNWALL, AND SOMERSETSHIRE.

June 26th. 1806. I SET out from *Windsor* on a new journey into *Devonshire*, and afterwards extended it into *Cornwall*, passing again through *Somersetshire* in my return. I have described, in my preceding travels, the first part of my road, through *Dorchester*, *Bridport*, and *Charmouth*, to *Arminster*. The latter place being in *Devonshire*, I shall from thence only begin my account of this journey, after a few preliminary remarks.

935. I think it necessary, first, to remind the reader, that he must not be surprized at again finding many descriptions of *rivers*, of the *vallies* in which both the main streams and their branches flow, and

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of

of the places where they discharge themselves into the sea. For besides that descriptions of this kind essentially contribute to give a distinct idea of the nature and aspect of countries, these objects are in themselves extremely important in Geology. It may have been seen in the *Elementary Treatise*, and in the *Introduction* to these Travels, that the question, whether *vallies* have been produced by *rivers*, is one of the first which arises in the History of the Earth. If such has been the effect of *running waters*, if to them are to be ascribed the principal forms of the present surface of the continents, the *origin* of the latter is carried back to a period of incalculable antiquity; and not only that origin, but the time during which they have been inhabited by men, is lost in the obscurity of past ages. On account of this intimate connexion between the history of *man* and that of the *continents*, geology is no longer to be considered as one of the sciences which interest those only who make them their particular study; for it is become of equal importance to every individual of the human race, that the introduction of error through this science be resisted.

936. When supposed *causes* are of such a nature as to produce certain *effects*, which accumulate proportionally to their duration, the existence of those causes can no otherwise be proved, than by showing an actual *progress* in their *effects*. Such a *progress*, therefore, should be observable in the *excavation* of *vallies*, and precise examples of that operation ought to

to be adduced ; but among the geologists who associate this excavating process with their several systems, none have undertaken to show that progress ; they all content themselves with using the following general and specious argument, which, in particular, has been employed by Dr. HUTTON and Mr. PLAYFAIR. Whenever there have been rains for a long continuance, we see the rivers and their various branches carry down earthy particles, which never return to the spots whence the waters, in their passage, have detached them : consequently, during the course of a sufficient number of ages, (it is of no importance what number,) these streams may have hollowed out the *vallies*. This operation is necessary especially to the distinctive hypothesis of the Huttonian theory, namely, that the materials carried off from existing continents are spread over the bottom of the sea, and there form mineral strata for succeeding continents. But the excavation of vallies by running waters belongs also to other theories, whereof the distinctive hypothesis, though differing widely from each other, yet agree in requiring that the time during which our continents have existed should be beyond calculation : it is therefore under this general point of view that I shall here consider the question respecting the *origin* of *vallies*.

937. On this head, it was become essential to examine,—1st. Whence are detached those earthy particles which are carried along by rivers in rainy seasons ;—2dly. Under what circumstances they



are detached ;—and 3dly. What becomes of them in their course :—a knowledge of these points being indispensable, when we are to determine whether the excavation of vallies is to be ascribed to this operation. Now as I judged, from the first, that this object was one of the most important in the study of the history of the earth, I directed my attention to it in my earliest travels among mountains and along the courses of rivers, the results of which I published in my *Lettres sur l'Histoire de la Terre et de l'Homme*, and there, from facts, I established the following propositions.—1. When, our continents, after their birth, were first watered by rain, a great part of their surface consisted, either in *strata* of soft substances, or in accumulations of the detritus of *stony strata*, over which vegetation did but slowly spread. Now during this period, that is to say, before such grounds were covered with grass, the rains washed down from them an abundance of earthy particles ; but this abundance was successively diminished, as these loose soils were externally bound by the roots of plants.—2. Again, the first *torrents* which were formed in the sinuosities, more or less deep, already existing on the heights, found those channels obstructed by the rubbish resulting from antecedent catastrophes of the stony strata ; this rubbish they drove before them, wherever there was sufficient declivity, and left it in the lower horizontal spaces of the *vallies* which they found at every height among mountains, or at the entrances of those large cavities now become *lakes*, existing also at different levels.—

3. The

3. The materials, brought down from eminences by the rains, have every where, without exception, raised the bottom of the original *vallies* in the parts where there was but little declivity. This operation has taken place, wherever the streams of the collected waters, finding spaces in which they could spread, have slackened their current; and this has been the case at all levels among mountains, as well as along the courses of the rivers in low *vallies*, down to the sea.—4. All the large materials have thus remained on the bottom of the *vallies*; and except in parts where rivers receive torrents towards the end of their course, nothing has ever been carried on to the sea, but the minute particles which float in the water, while its volume gives rapidity to its current, notwithstanding the smallness of the declivity.—5. The transportation of large materials by running waters has therefore long since ceased, except where rapid torrents formed by abundant rains, have cut their way through slopes of the rubbish produced by the crumbling down of steep sides, and have not yet sufficiently widened their channel, nor cleared it to the solid rock. Now here already we have a *chronometer*; for in passing over mountains, and even stony hills, we find many channels of ancient torrents, which have been thus cut in large heaps of rubbish; and of which the sides are now bound by vegetation; while [in others, the sides continue to crumble down, because their demolition has not yet carried them far enough back to be out of reach of the torrent when it is swelled. If the continents were

were of unfathomable antiquity, all these operations would certainly have been long since terminated.—

6. astly, wherever the stream has more space to spread, and its rapidity is consequently diminished, after the cavities in its course have been filled up, and the bottom levelled, the earthy particles, which had floated in the water while it was rapid, are deposited on its borders. Hence originate the *alluvial* soils formed in some parts of the courses of all rivers and their branches, from the highest vallies among mountains, down to the sea. In many places, the *progress* of these new soils within determined *periods* is well known; and when this *progress* is compared with the *totality* of the effect, which is always visible, it is impossible to suppose that our continents have existed during any very great number of ages.

938. These are facts very opposite, as well to the hypothesis of the excavation of vallies by running waters, as to its consequences, with regard to an immemorial antiquity in our continents. When I established these facts in my first geological work, I gave of each of them some precise examples, which, I expected, would be sufficient to fix the attention of all persons interested in the history of the earth, who, from such instances, might every where discover the same effects, produced by the same visible causes; and I proceeded immediately to the geological consequences naturally resulting from them. In this expectation I was deceived; and many works  
have

have since appeared, wherein operations, the existence of which I had refuted, are again considered as certain, while to those really existing no attention is paid. This is particularly the case with Mr. Playfair, who, having himself observed but little, has only quoted from the works of others such passages as he has thought favourable to the theory of his friend Dr. Hutton; a circumstance by which, as I have said, I was determined to continue my observations in *England*, and particularly in the counties referred to in his work.

939. It is for this reason that I have already described the mouths of the rivers in the counties of *Suffolk* and *Essex*, on the eastern coast of *England*; those of the rivers of *Somersetshire* and *Gloucestershire* on the western coast; and on the southern, whence Mr. Playfair principally takes his examples, those of all the rivers of *Hampshire*, *Dorsetshire*, and *Devonshire*, except the *Ax* and the *Otter*, in the latter county. Now these rivers, as I have evidently shown, have been so far from forming the openings through which they arrive at the sea, that their sediments, together with those of the tides, are tending to obstruct these openings. In my present journey, I observed the mouths of the *Ax* and the *Otter*, which I had not had an opportunity of seeing the year before; and going on into *Cornwall*, I examined those of all the rivers around the whole coast of that peninsula, it being on the latter that Mr. Playfair lays the principal stress. I observed also the  
rise

rise of nearly all the rivers of that county and *Devonshire*, together with great part of their courses. Moreover, while I pursued these last observations in the interior parts of the country, I particularly fixed my attention on the *mineral strata*, their situations, and their relative associations, especially in the parts where *granite* appears, this being likewise an important object in the examination of the Huttonian theory. Such are, briefly, the principal points of my observations in the following travels, in the course of which will also be introduced many other geological objects intermixed with the above.

*June 28th.* In arriving from *Charmouth* on the top of the hills dividing *Dorsetshire* from *Devonshire*, the latter county presents one of those beautiful rural prospects, which are so frequently to be seen in this part of *England*. The soil being very fertile, the fields are separated by fine hedge-rows interspersed with trees, and the meadows, through which the *Ax* meanders, extend on both sides to a great distance. *Arminster* stands in the middle of this cheerful landscape; and by this town the river passes in its way to *Armouth*, where it falls into the sea.

940. As I descended the hills on this side, I again found on their slope those *strata* of yellowish *limestone*, which I had observed beneath the *chalk* in various parts of *Dorsetshire*. These strata present their section on the side next the valley of the *Ax*; and in the projecting parts, where their lateral sections

sections appear, they are seen to incline inwards. Longitudinal fractures, attended by successive subsidences towards the valley, form here several terraces, one below another, such as I have already described on the slopes of many other hills; and this valley has certainly not been hollowed out by the river; for besides that the latter has raised the soil by its sediments, on which the meadows are formed, these hills on the left side are of great height, while those on the right are very low. From the slope of the former hills, I saw also large meadows in another vale on the western side, containing one of the principal branches of the *Ax*, called the *West waters*, formed by the junction of some small streams which I had afterwards an opportunity of observing.

941. I did not stop at *Arminster*, but proceeded immediately to *Honiton*. I had again entered *Devonshire* by this road, because I was first going to *Ashfield*, a house on the southern slope of the *Blackdown hills*, a little more than a mile beyond *Honiton*, to which I had been invited by Mrs. M. A. BURGESS, with whom a particular object had brought me into correspondence, though I was not yet personally acquainted with her; and her wish to promote my views has since induced her to undertake the translation of my travels. When I made her this first visit, she had resided twenty years in *Devonshire*, and was well acquainted with many parts of it, especially on the coasts. I found her living in a very pleasant neighbourhood, in which I have since spent much time in  
a man-

a manner no less agreeable to me than conducive to my purposes. Mrs. Burges, and her very worthy friend Mrs. A. ELLIOTT, who has also long been settled here, being intimately connected with the family of General SIMCOE at *Wolford Lodge*, which is at the top of a combe in these hills, and having had an opportunity of purchasing fields adjoining to each other in the same combe, have built there two houses, very pleasantly situated; *Eglands* is the name of Mrs. A. Elliott's house, as *Ashfield* is of Mrs. Burges's. These hills themselves, which, in my first journey, I had not stopped to examine, formed, in the present, one of my particular objects. I had mentioned my wish to observe them in a letter to Mrs. Burges, who having spoken of it to General Simcoe, he was so good as to offer me his assistance in the most friendly manner. I shall never forget that excellent man, whose character endeared him to me even more than the services for which I was then indebted to him; and it occasioned me the most lively regret that the friendship which I then formed with him, and have since continued with his estimable family, was so soon interrupted by his death; but he still lives in the memory and regard of all who had the advantage of being intimately acquainted with him.

942. I shall now explain on what account I was desirous to obtain a particular knowledge of this part of *Devonshire*. It has been shewn in the *Elementary Treatise*, and in the *Introduction* to these *Travels*, that one of the phenomena which characterize,

as well the *nature* of the catastrophes undergone by our *mineral strata*, as the *place* and the *period* of those events, consists in the *masses of stones*, of various kinds, scattered on the surface of the continents, as well on the summits and slopes of hills, as in plains. In order fully to judge of the connexions of this phenomenon, and of its importance in Geology, all its different circumstances, well determined, must be embraced, and no hypothesis must be framed for particular cases, considered as merely *local*, while they are in reality common to many countries.

943. This is a defect into which Mr. Playfair has fallen, from his prepossession in favour of the Huttonian theory; wherein it is supposed that, since the birth of the continents, the *stones* scattered over their surface have been disseminated by running waters; an hypothesis which would require that these continents should be of an incalculable antiquity, but which cannot account even for the most inconsiderable number of the cases constituting the whole of this great phenomenon. Mr. Playfair, having himself met with some places where this hypothesis is inadmissible, has considered those as local exceptions, and has formed particular hypotheses for the purpose of explaining them: of this, an example relating to the hills which I have just mentioned appears in the following passage, p. 373. “ The road  
 “ to *Exeter* from *Taunton Dean*, between the latter  
 “ and *Honiton*, passes over a large heath or down,  
 “ considerably elevated above the plain of *Taunton*.  
 “ The



“ The *rock* which is the base of this heath, *as far as*  
 “ can be *discovered*, is *lime-stone*, and over the sur-  
 “ face of it large *flints*, in the form of gravel, are  
 “ very thickly spread. There is no *higher* ground  
 “ in the neighbourhood from which this gravel can  
 “ be supposed to have come, nor any *stream* that  
 “ can have carried it, so that no explanation of it  
 “ remains, but that it is formed of the *flints* con-  
 “ tained in beds of *lime-stone*, which are now worn  
 “ away. The *flints* on the heath are *precisely* of  
 “ the kind *found in lime-stone*; many of them are  
 “ not much worn, and cannot have travelled far  
 “ from the *rock* in which they were originally con-  
 “ tained. It seems certain, therefore, that they  
 “ are the *debris* of *lime-stone* strata, now entirely  
 “ decomposed, that once lay above the strata which  
 “ at present form the base of this elevated plain,  
 “ and probably covered them to a considerable  
 “ height.....The same remarks may be made on the  
 “ high plain of *Blackdown*, which the road passes  
 “ over in going from *Exeter* to the westward. The  
 “ *flints* there are disseminated over the surface as  
 “ thickly as in the other instance, and can be ex-  
 “ plained only on the same supposition.” There is  
 here a topographical mistake, which I must ex-  
 plain, because of the descriptions that will follow.  
 The *Blackdowns* are the hills passed over between  
*Taunton* and *Honiton*; and those to the westward of  
*Exeter* are the *Haldon hills*.

944. If Mr. Playfair had known how common are the two circumstances which he has here remarked, namely, that there is neither any *higher ground in the neighbourhood, nor any stream that can have carried the stones alluded to,* he would not have sought a particular cause for the explanation of the flints scattered over the *Blackdown* and *Haldon hills*. In countries where *hills* are the only eminences, these circumstances must always belong to their *summits*; which however are, for the most part, covered with larger or smaller stony masses, not only of kinds known to have been formed within certain *strata*, as the *silices*, but *fragments of strata* of various species, and these masses, as I have shewn in my preceding travels, are often different on ridges of hills forming the opposite sides of the same valley. It would therefore be necessary to have recourse to as many particular explanations, as there are differences in the nature and situation of these scattered stones; and this has in fact been done by Mr. Playfair with respect to another case in *Worcestershire*, between *Broomsgroce* and *Birmingham*, which he has proceeded to adduce in the same passage. This spot also I have visited; and when I shall come to that part of my travels, I will mention what is said of it by Mr. Playfair. Nothing can involve the natural sciences in greater obscurity than such attempts to explain by particular causes, differing from each other as the particular cases happen to differ, those phenomena which, from their common characters, must be connected by one general cause. :

945. Still

945. Still however, if, in the case here in question, “ the rock which is the base of the heath or down of the *Blackdown hills, as far as can be discovered,* “ were really of *lime-stone*;—if its strata contained “ *flints*;—if those scattered on the heath were “ *precisely of the kind found in this lime-stone* ;” circumstances all taken for granted by Mr. Playfair, we should have no reason to be surprised at his explanation, for it would be an immediate conclusion from facts. Thus readers, unused to observations of this kind, and not doubting the reality of the facts, must have considered them as affording a proof that our continents had been subjected to atmospherical actions, during an incalculable number of ages. But, as I have been more accustomed to observe natural phenomena, as well as to judge whether other observers had taken the necessary precautions to ascertain the facts which they described, and as I did not find in this passage of Mr. Playfair any reason to suppose that he detailed these circumstances, from his own observation, I conceived that he spoke only from casual reports, and that he had himself seen nothing more in travelling along this road, than the phenomenon of the *flints* scattered on the heath. It was on this account that I had determined to observe all these hills, with the various circumstances attending this phenomenon, which therefore was my first object in the present journey; but these circumstances proving very interesting, I extended my observations farther than I had designed; and it was not till the following year that I visited a spot near which Mr.

Playfair

Playfair has passed in travelling along the strait road from *Taunton* to *Honiton*, over the eastern extremity of the *Blackdown hills*, and to which he probably alludes, though certainly without having seen it. But before I shall come to the description of this particular part, Mr. Playfair will have found sufficient reason to judge that he must have been ill informed by those to whom, without doubt, he addressed himself on the road; as is very frequently the case with travellers.

946. My observations in this part of the country will embrace many different objects, all relating to these *flints* and their origin; in order, therefore, that they may be clearly understood, I shall begin by giving a brief description of the *Blackdown hills*, of which the circumstances essential to the subject will be successively seen, when I shall proceed to particular details. The first point to be examined concerned the *lime-stone*: now I have made many excursions on these hills, as well on their summits as on their slopes; and I have not found this stone in any part, except the spot above mentioned. In every other part of the *Blackdown* ridge, the base of these high heaths, though completely overspread with flints, consists *as far as can be discovered*, of nothing but strata of *sand* and *sand-stone*. Moreover, the *flints* spread over these hills differ from the chalk flints by the size of some of their masses, by their colour, and especially by the *calcedony* with which many of their cavities are lined, a character not found in those  
 belonging

belonging to any of the calcareous strata of this country.

347. The *Blackdown hills* form the western side of the valley of the *Otter*, from the origin of that small river, seven or eight miles above *Honiton*, to within some distance of *Ottery St. Mary*: there these hills cease to follow the river, but they extend considerably in breadth towards the west; and their whole outline bears the impression of the *subsidences* to which the low grounds at their foot are to be ascribed. I must here remind my reader of the meaning of the word *combe*, which is well understood in these countries and many others, but which ought to have a correspondent term in all languages, as well as those of *vallies* and *vaies*; it being one of the most important features of the surface of the continents. *Combes* then are *cavities* very frequently wider and deeper than many of the *vaies* through which rivers flow; though it is impossible they can at any time have afforded a passage to rivers, for it is their nature to terminate in the upper part of ridges of hills; inso-much that through many of them no water ever passes but that of the rains which fall on the grass wherewith they are covered. It is in the very cause of the formation of *combes* that the small permanent streams flowing in some of them originate; I mean a *subsidence* between two *fractures*, by which have been produced, in the sides of these cavities, *sections* of the *strata*, where the waters filtrating through the upper soils find an issue; and the streams formed by the

the junction of the waters of these lateral springs are more considerable, proportionally as the *combes* extend farther before they terminate towards the top of the hills.

948. This is one of the circumstances indicative of the catastrophes to which the *Blackdown hills* are to be ascribed: for they are now *eminences*, only because the masses originally forming the continuation of the *strata* that compose them *subsided* around them; that *subsidence* having been followed by many other changes, while they were still covered by the sea, and consequently at a period anterior to the birth of the continents. The whole circumference of this chain of hills is intersected with *combes*, producing grass or corn on a loose soil, which is different from that of the higher parts, and therefore cannot have been washed down from them by the rains. Three principal *combes* succeed each other along the right bank of the *Otter*, from the point where the eastern extremity of the hills is crossed by the high road from *Taunton* to *Honiton*; these are called *Combraleigh*, *Awliscombe*, and *Hembercombe*; and they lie between promontories which differ in breadth, and have likewise distinctive names: *Combraleigh* is between *Hartridge hill* and that of *St. Cyres*, called also *Combraleigh hill*; *Awliscombe* is between the latter and *Hembury Fort hill*, so named because of an ancient camp, commonly supposed to be Roman, of which there are still vestiges at its extremity; and *Hembercombe*, wherein is the village of *Broad Hembury*,

*bury*, is between *Hembury Fort hill* and *Upcot Pen*, forming the termination of the *Blackdown hills* on this side. All these promontories have themselves experienced the effect of the catastrophes which produced the valley of the *Otter*, and the combes communicating with it: across *Hartridge hill* there is a wide intersection; the extremity thus cut off, named *Dumpton hill*, is of equal height with the rest, and also has on it the remains of a camp: the end of *Hembury Fort hill* is cut down abruptly below the camp or fort; and at some distance in front of this, near the village of *Buckerell*, there is a low hilly ridge nearly insulated, which is called *Buckerell knap*. Such is the aspect of the *Blackdown hills* on the southern side, where every circumstance renders it manifest that not only these combes, but the transversal fractures of the promontories, are consequences of the catastrophe which formed the valley of the *Otter*, itself very irregular; and of this farther indications will appear, in the following detail of my observations.

*June 29th.* I went with Mrs. Burges from *Ashfield*, which is in the parish of *Awliscombe*, to *Wolford Lodge*, whither General Simcoe, with Mrs. Simcoe and part of his family, had returned, on purpose to receive me, from another house belonging to him at *Budleigh Satterton*, a village on the coast near the mouth of the *Otter*, where he frequently resided. Knowing what were the objects that I wished to observe, he led me that first day along an abrupt part

of the hill called *Pen point*, which advances into the combe on the western side of his house, and of which the foot has been cut to form a walk. He shewed me there the natural strata of the hill; for their *section*, produced by some anterior cause, is seen wherever the loose soil of the slope is cleared away. The strata thus discovered are considerably below the surface over which the *flints* are scattered: now at what period could these strata have been formed? Can we suppose that, according to the hypothesis of Mr. Playfair, it was subsequently to the origin of the continents, and by the decomposition of any kind of strata containing the *flints*? A direct proof to the contrary here appears; for these *strata*, in which there are no flints, consist of pure *sand*, and not *limestone*; and as they contain a multitude of small marine shells, chiefly *chamæ* and *gryphites*, they must necessarily have been formed on the bottom of the sea, such as they now are. This *sand* is so fine, so pure, and so loose, that it easily crumbles down; and the *shells* are so brittle, that few of them can resist the pressure of the fingers. They must have been penetrated with some acid, which does not abandon the calcareous earth to nitrous acid; for when the latter is applied, no effervescence is produced. In this sand are concretions formed around some of the marine bodies, which are preserved within them. I have seen in other places sand, and even clay, wherein all the shells have vanished, except those enclosed in similar concretions. There are also in these *strata* some singular *geodes*, which,



within an argillo-ferruginous crust, contain a black powder, becoming deep red on exposure to the air ; but I have not had an opportunity of knowing more of its nature.

949. Here then already we find very distinct *strata*, which lie much below the surface covered with *flints*, and belong to the *base* of the hill ; but they are not of *lime-stone*, as Mr. Playfair had supposed. Besides, it is evident that they were formed in the sea, such as we now find them, since they contain vast quantities of its shells, which must have been deposited there, like many others that I have described, chiefly in *Dorsetshire* and *Hampshire*, at a period much *anterior* to that of the retreat of the sea into its present bed ; for no *gryphites* are now found on these coasts.

*July 1st.* Having returned to *Wolford Lodge*, General Simcoe led me on the summit of the *Black-down hills*, behind his house, where we saw a great extent of common, which he had just begun to enclose. The soil consists of a yellowish argillaceous sand, intermixed with angular fragments of *flint* ; and in some places, large masses of these stones lie on the surface in such astonishing abundance, that there is scarcely room for grass and heath to spring up between them. The largest flints had been picked up and collected into heaps, wherever cultivation was intended ; and I saw afterwards several more of these heaps in other parts of the same hills. The  
flints

flints abound on the slopes as well as on the summits, and lie at a greater or less depth under loose superficial soils, which, in different places, are of different kinds; and some of the masses of these stones are not less than five feet in length.

950. As for the nature of these *flints*, they are very brittle, being easily broken with a hammer; most of them are mutilated, but such as retain their original surface have the crust which is common to *flints*: they differ much in transparency; the most transparent are of a yellowish colour; in proportion as they are more opaque, they become whiter, and some are absolutely white; yet these strike fire with steel like the others. But the circumstance which, as I have already mentioned, most distinguishes them from the *flints* in *chalk*, the only kind of *strata* in this country wherein flints are found, is that many of their cavities are lined with mamillary *calcedony*, generally yellowish, but sometimes of a milky colour, like opal. These flints contain marine bodies, many of which were shown me by general Simcoe; they are chiefly *echinites*, (not found in the lower strata,) and *chamæ*: in some of the stones there are cavities retaining impressions of marine bodies; but there are various kinds of shells to which the striæ observed in them may be referred. Some of these cavities appear to have been produced by *entrochi*; the bodies themselves are destroyed, but the cavities preserve their form, the centre being occupied by a small column of *silex* moulded within the tube of the *entrochus*;

*trochus*; I have seen the same circumstance in stones of other kinds. Mrs. Burges has in her collection a small *cornu Ammonis* found in the gravel near *Eglands*, which must have belonged to these flints; the shell itself is destroyed, but the nucleus is semi-transparent, and in a cavity appear calcedonic mamillæ.

951. Such is the surface of the *Blackdown hills*, very similar to that of the *Haldon hills* on the westward of *Exeter*; and had Mr. Playfair stopped to examine it, his hypothesis would certainly never have presented itself to his mind: for if these *flints* had been contained in *calcareous strata* decomposed by the atmospherical actions, they would be found accumulated on the remaining *strata* of the same kind, the decomposition of which would still continue. Mr. Playfair himself has observed that there is no ground here higher than these hills, whence the *flints* could have been brought down; he might therefore have comprehended that neither could the loose soil in which they are buried, in many places to a great depth, have been brought from any other spot on the existing continent. Lastly, by examining the *flints* themselves, he might have seen their dissimilarity to those of the *strata* of *chalk*, the only *calcareous strata* in which, as I have already said, any *flints* are in this country contained.

952. These

952. These *flints*, indeed, must certainly have been formed in some kind of *calcareous strata*, but they were disengaged by the *dissolution* of those *strata*, while still covered by the *sea*; for, as I have said above, the mass of the hills, so far as it is known, is composed only of *strata* of loose *sand* or *sand-stone*. In some parts, the uppermost *strata* contain *ferrous concretions*, fragments of which have been spread over the surface by the catastrophes. General Simcoe carried me to one of the summits, where he showed me a great number of ancient pits, made, as is supposed, by the Romans, for the purpose of taking out these concretions, and extracting iron from them. In these cavities are found quantities of very heavy blackish stones, and iron scoræ, whence it should seem that the ore was smelted on the spot. I shall now show what kinds of *strata* prevail between these of the summit of the hill, and the others at a lower level, in the grounds belonging to *Wolford Lodge*, which I have already described, and which no less evidently are *original strata*, since they contain *marine bodies*.

953. General Simcoe led me down from this summit to the upper part of *Hembercombe*, between *Hembury Fort hill*, and *Upcott Pen*, where are worked two different *strata* at a small vertical distance from each other, which will show still more distinctly what is the *base of this heath* covered with *flints*: the sections of these *strata* appear towards the part where the declivity is most rapid; they are both

both of *sand*, partly consolidated in large *concretions*, and they are separated by a stratum of pure *sand*. This is a new example of the phenomena which so evidently prove that the *solid strata* have not been indurated by *fusion*, as is pretended in the Huttonian theory; for had such been the cause of their consolidation, the whole of these *sandy strata* would have been affected by it.

954. These *strata* are worked principally on account of the *concretions* contained in the lowest, which are used as *whet-stones*, to sharpen scythes, reaping hooks, and other coarse instruments. When these masses are first taken out of the quarry, they are easily split, according to the direction (known by the workmen) in which they had lain in the stratum, into flags about two inches thick; and these, while they still retain the humidity of the quarry, are divided across into equilateral pieces about nine inches in length, which afterwards, with a kind of hard steel-edged hatchet, are cut into the shape of a weaver's shuttle. Although the concretions, while in this state, are so easily cut, yet the sand that composes them is extremely hard, for in this operation abundance of sparks are continually produced; but the stones thus cut become very hard themselves, when they have had time to lose their original humidity.

955. This, as I have said, is the *stratum* principally worked; but, for that purpose, it is necessary  
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to open galleries of the height of a man ; and these are carried through the upper *stratum* which also contains concretion, and through that of pure *sand* which lies between them. But the *concretions* in the upper *stratum* are very different from those in the lower ; they are much softer, and cannot be used as *whet-stones* ; it would not be worth while to work this *stratum* alone, but, as it must be removed for the purpose of following the other, its *concretions* are used for building stones ; and the largest of them may be cut with the chisel for various purposes. The *Whet-stones* being particularly good, and on that account carried to a great distance, many quarries have been opened, nearly at the same level, all around the upper part of *Hembercombe*, from *Hem-bury Fort hill* to *Upcott Pen*.

956. These quarries are worked in the following manner. The slope is first cleared away up to the *section* of the *strata*, covered more or less with loose soil : and the earth thus removed forms on the slope, in the part where the *strata* are discovered, a kind of terrace, on which the workmen have their sheds and tools, and which is widened by the sand brought out of the quarry, and the rubbish of the stones that are cut on it. A gallery is there opened, of a height including both the *strata*, and of a breadth sufficient to allow two men with wheel-barrow to pass each other ; for as they advance, it is necessary to carry out, not only the stones which are detached, but the sand of the intermediate *stratum* : this first  
gallery

gallery is carried on only about 500 feet into the hill, in order not to lengthen too much the way for the wheel-barrows. The workmen afterwards begin again, from the entrance of the quarry, cutting to nearly the same breadth as before, but now throwing the sand, and such of the concretions as are useless into the space already cleared. In this manner they will continue to work, stopping always at the same point, as long as the section of the strata shall be found sufficiently near the surface of the slope. These strata have been worked around this hill for many ages; for the men told me that, in carrying on their galleries in the parts where they work at present, they sometimes meet with ancient galleries in a different direction, of which neither the date, nor the points where they had begun, are now known, it being useless to investigate those circumstances.

957. Passages into the interior parts of *hills* are scarcely ever opened, without finding indications that the whole mass of the strata has been *fractured*, with unequal *subsidences* of the divided parts: and this is seen here, as well as in other quarries, which I have already mentioned, especially in those of *Perbeck* (§ 664). I followed one of the galleries in *Upcott Pen* to its extremity; and the workman who conducted me showed me a space of about fifty feet, in the direction of the length of the gallery, between two fractures, where the *strata* have sunk lower than the adjacent masses; so that the *stratum* of  
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the stones used in building, which, in other parts, is at the top of the gallery, is here at the bottom, the *stratum* of the whet-stones having sunk about five feet below it; and this change of level could not have taken place without an equal subsidence of all the *strata* beneath. The breadth of the mass here sunken being inconsiderable, the change of level small, and these strata much below the surface, this internal dislocation is not discernible, among other irregularities, on the top of the hill; but, after having seen the interior part, it is easy to judge that the many great inflexions of the surface proceed from a similar cause; and that, if these strata were followed very far inwards, they would suddenly be totally lost: this is also the opinion of the workmen, who told me that, in some of the other quarries, the sudden changes of level were much greater than in this. My guide informed me besides, that, at some depth below the stratum now supplying the whet-stones, there is known to be another of the same kind, which, however, they do not intend to work, so long as, in the upper stratum, they can extend their quarries in breadth, without carrying them much farther inwards; because the galleries must always begin at the section of the strata, and the depth of this lower stratum is such, that its section cannot be laid open on the slope, without removing a great mass of loose soil belonging to the combe. It is thus that the sections of the strata produced by the subsidences of which vallies are the effect, are seldom seen in the sides of hills: because these catastrophes were followed,



lowed, still under the waters of the sea, by other operations, whereby the original sections of the strata were covered with materials of various kinds.

958. Thus the *strata*, on the surface of which are scattered the masses of *flint*, are known to a considerable depth in this part of the *Blackdown hills*, and there is not among them the smallest trace of *limestone*; they consist of *sand*, which, in some *strata*, is concreted in masses; and a proof that these strata were formed on the bottom of the sea, before the birth of the continents, is afforded by the marine bodies contained in them. I have already spoken of those which are found in abundance at a lower level, in the *strata* laid open near *Wolford Lodge*, and there are also great quantities in the *strata* just described, as well in the sand, as in the concretions; but a change in the state of the sea had taken place subsequently to the production of the former *strata*, for the shells in the latter are very different; and the late worthy Mr. EDWARD DREWE, the clergyman of *Broadhembury*, procured for Mrs. Burges a great variety of them; among which are, first, large *ostreae* and *chamae*; but of these scarcely any can be found entire, though their substance is become extremely hard, having been transformed into *flints*; whence it is manifest that the particles which have united the *sand* in the *concretions* have been *siliceous*. I have seen elsewhere transformations similar to the above, though differing in species; for instance, in  
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the *mountain of Turin*, where the *strata*, composed of *sand* mixed with gravel of *serpentine*, contain *concretions* formed by *alabastine* particles, the substance of the shells enclosed in them has been changed into *alabaster*. In the *strata* of *Upcott Pen* there are also *tur'lines*, which directly prove this circulation of *siliceous* particles among the *sandy* *strata*; for in these shells the revolutions most distant from the mouth, and consequently narrowest, not having been entered by the sand, are filled with semi-transparent *silex*, as I have seen those in other places with *agate*. Besides these, there are here many other kinds of shells, *mytili*, *neritæ*, *ostreæ* resembling *gryphites* deeply channelled, and even *cornua Ammonis*, proving the remoteness of the period at which these *strata* were formed in the sea: one of Mr. E. DREWE's daughters showed me a large *cornu Ammonis* found in these *strata*, the shell of which is very well preserved, and is thicker than any that I have had an opportunity of seeing elsewhere.

959. Such are the *strata*, "as far as can be discovered," of the *Blackdown hills*, under the scattered *flints*. Though these *strata*, as I have said, consist mostly of *sand*, there are differences between them, both at different depths, and in different parts of the hills; and since the superficial *flints* can neither have been disengaged from *calcareous strata*, nor transported hither from higher grounds on the existing *continents*, and since also the *strata* on which they rest,

rest, down to the known depth, contain *marine bodies*, no other *explanation* can be given of these phenomena than the following; that, before the continents were abandoned by the sea, the *flints* had already been scattered on these strata, no change having since taken place, except that the flints are now in great part overspread with heath and other plants.

960. Our *continents* may indeed appear of an immeasurable antiquity, when the operations, which were really effected while they still formed the bed of the sea, are supposed to have taken place on them since they have become dry land; but such a supposition can only proceed from the want of sufficient attention to the whole of their phenomena. All the monuments of our globe concur in demonstrating, that, before the great revolution which changed the *bed* of the sea, its ancient *bed*, now become our *continents*, had been the theatre of a long succession of catastrophes of *strata* already formed, of productions of new *strata* different from the preceding, and of new catastrophes of all the *strata*, until that change of the bed of the sea, by which all these operations were terminated. The changes in the *precipitations*, whereby were produced *strata* successively so different from each other, could not have been occasioned any otherwise than by changes in the *liquid*. After the termination of certain *precipitations*, new ones of a different kind could not have been produced but by the introduction of new *ingredients* into this liquid; and it was in consequence of the catastrophes

trophes of the *strata*, that such ingredients ascended through their crevices from the interior parts of the globe. These are the first and indubitable conclusions from visible existing monuments, and they lead to the explanation of a number of phenomena which would otherwise be unintelligible to us.

961. In my *Lettres sur l'Histoire de la Terre et de l'Homme*, I have circumstantially explained the phenomena of various kinds, on which is founded the idea, that, after the production of certain *strata*, the sea having been deprived by new *precipitations* of a part of the ingredients still remaining in it, and other ingredients having entered it from the interior part of the globe, it became capable of redissolving some of the *strata* which it had before produced, in the places where those *strata* still continued uncovered by others. These operations are conformable to the general laws of *affinities*; many examples of them are seen in our laboratories; and by this process only can be explained the *strata* of fossile *salt* which we find in some parts of the mass of our continents, and which were certainly formed by precipitation on the bed of the sea: but before its liquid was reduced to its present state, and thus rendered capable of dissolving them, they were covered by other *strata*, which prevented its access to them. It was by a similar combination of changes, that, at a certain period, the water of the sea, on different parts of its bed, became capable of dissolving certain *calcareous strata*, thus leaving on its bottom those  
*bodies*

*bodies* which had been formed by a transmutation of their substance, and on which it had no longer any action.

962. When I treated of this subject in the work above cited, and also in my Letters to M. DE LA METHERIE in his *Journal de Physique*, I dwelt only on the chief phenomenon of this latter class, namely, that of the common *flints*, known to have belonged to *chalk*, yet scattered over immense tracts of ground, in countries where no *stratum* of *chalk* appears. I have had occasion however since, to add, in the IVth of my *Letters to Prof. BLUMENBACH*, (Paris edition,) some observations by my nephew, whom I have already mentioned, shewing that this dissolution has taken place even on some *strata* of *chalk*, part of which still remain, and are covered with *flints* that here have evidently proceeded only from dissolved *strata*. These observations were made in *Sussex*, where the cliffs on the coast at *Sea-houses*, near *East-bourn*, and especially at *Beachy head*, present the section of *chalk strata* very much inclined; so that, in walking along the strand, and consequently at the same level, they are seen to pass successively from the hardest strata without *flints*, to soft strata in which there are great quantities; the latter differing from the former with respect likewise to the nature of the marine bodies contained in them. My nephew went over the upper part of these hills, and sent me a sketch of the sinuosities with which he found their whole surface intersected, and which had the appearance

pearance of having been the work of streams ; but none flowed over these hills ; at last it occurred to him that they had been produced by *dissolving currents* on the bed of the ancient sea ; and he was confirmed in this idea by finding, at the bottom of the hollow parts, a quantity of *flints* proportional to the mass of *chalk* which had been dissolved there.

963. The certainty of these dissolutions of *strata*, while still on the bottom of the sea, will be more particularly shewn by some other phenomena which I shall now relate, belonging to many kinds of bodies of the class of *silices*, scattered over several parts of the continents, and certainly formed in *calcareous strata*, though no strata of that species are found within a great distance ; as is the case with respect to those in which the *flints* of the *Blackdown* and *Haldon hills* have been formed. These bodies are of various species ; but I shall confine myself to *agates*.

964. When I was at *Coblentz*, on the left bank of the *Rhine*, near the confluence of that river and the *Moselle*, a great excavation had recently been made, for the purpose of building there a new Electoral palace. Eight feet of *sand* had been dug through, being the alluvial land of both the rivers, accumulated since the time of the Romans ; their sepulchres having been found under this sand, in *gravel* increasing in size proportionally to its depth. This *gravel* almost entirely consisted of rounded fragments of

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known *strata* ; but among these I found some *agates*, of species which had been described by M. COLLINI, in his *Journal d'un voyage minéralogique* published in 1776, and of which I had seen a collection at *Manheim*, in the cabinet of natural history formed by that gentleman, who had the direction of it. Among other interesting objects treated of in that *Journal*, M. Collini describes several places in the dutchy of *Deux Ponts*, and in a tract of land between the *Rhine* and the *Moselle*, where these *agates* are scattered on the ground ; wherefore it is not surprizing that some are found in the gravel of the alluvial soil near the confluence of those two rivers. In particular, he gives an account of a celebrated hill near *Oberstein*, at no great distance from this spot, where the *agates* are found in such abundance, that they have become an article of manufacture and commerce ; being cut and set in trinkets of various kinds.

965. According to M. Collini's description of this hill, and the figure given in an annexed plate, it is composed of *strata* of *pudding-stone*, which have undergone the catastrophes common to all the *strata* ; and the extraneous bodies contained in these *pudding-stones* are chiefly *agates* ; they are found there with the usual *crust* of silices, and are easily detached from a ferruginous ochre in which they are imbedded. There was a person at *Coblentz* who traded in them ; and in his shop I saw all the different kinds of bodies found at *Oberstein*. There was a  
great

great variety among them, from the *onyx* and the *sardonyx* to the most transparent *agates* of different colours; there were also some *geodes*, the external shell of which was of *onyx*, and the inside was lined with fine crystals of *amethyst*. All these bodies, as I have said, were covered with a *crust*, shewing, as is the case with *flints*, a gradation in the transmutation of the substance of the *stratum* wherein they were formed into that of the siliceous body; a transmutation produced by particles of various kinds, which had once circulated through the *strata* while they were still on the bottom of the sea, and which, were retained by some obstacles, had combined with the substance of the *stratum*. This transformation is similar to that of the shells of *Upcott Pen* into *flint*, of those of the mountain of *Turin* into *alabaster*, and of many fossil woods into *agate*; and in all siliceous bodies the *crust* participates in the nature, both of those bodies, and of the *stratum* in which they were formed. In a part of the *Jura* called *Combe de Mijour*, my brother found a phenomenon of the same kind, shewing the above transition: this phenomenon consists of *geodes*, lined with transparent crystals of quartz; the *crust* being quartzeous within, while its exterior surface remains lime-stone; which, in some specimens, even contains parts of *madrepore*, probably the cause of the stagnation of the quartzeous particles circulating in the *stratum*. He found these *geodes* only among the gravel scattered on the bottom of the *combe*; and though he is very well acquainted



with the *Jura*, he never met with any of them in existing *strata*.

966. M. Collini, being more occupied with mineralogy than with Geology, and having never visited any other countries than those which he has described, thinks that the *agates* of *Oberstein* may have been formed in the very *strata* wherein they are at present found, and endeavours to explain their formation by some combination of ferruginous and argillaceous substances within these *strata*. According to this hypothesis all the bodies collected in *pudding stones* might be supposed in the same manner to have been formed within the substances now containing them. But M. Collini himself describes hills of *schistus* on both sides of the *Rhine*, a part of which I have observed: their surface, in many places, is covered with fragments of *white quartz*, both in large masses and in *gravel*, and *pudding-stones* of this *gravel* are also found in the same hills. This is exactly analogous to the phenomena of the *agates* above mentioned; which, being scattered on the surface throughout a great extent of country, are in *pudding stones* at *Oberstein*. And moreover, this phenomenon belongs also to the common *flints*, which, in countries where there is no *chalk*, are scattered over hills, and are likewise found in masses or *strata* of *pudding-stone*: in the sequel of these travels I shall describe large masses of *pudding-stone* containing fragments of *strata*, which, though well known, are nowhere found in the neighbourhood.

967. All

967. All these cases, as they relate to scattered masses, have a general analogy with that of the *flints* on the *Blackdown* and *Haldon hills*; on which I should not have dwelt so long, had it not formed a part of an important geological phenomenon obscured by Mr. Playfair's hypothesis. There are on these hills, as I have shewn, *flints* of a species not found in any *calcareous stratum* of this country: they cannot have been scattered here by any cause since the continent has existed; nor can they be considered as the residuum of *calcareous strata* decomposed by atmospheric actions, because they lie on *sandy strata*; abounding with *marine bodies*, and therefore produced in the sea. The *flints* then were scattered here by the same cause which elsewhere disseminated the *agates* and other masses of their kind; and the disengagement of all these from the strata originally containing them cannot be referred to any other period than that during which the continent was still the bed of the ancient sea, the greatest laboratory that has ever existed on our globe: this same country will moreover presently afford me a great and interesting example of the astonishing revolutions which happened on that bed of the sea, and in particular of catastrophes and destructions of *calcareous strata*, long before the birth of our continents.

968. In the 1st. Vol. of the *History of Devonshire* by the Rev. Mr. POLWHELE, I had read the description of quarries in a white *lime-stone* resembling *chalk*, situated in some hills in the parishes of  
*Widworthy*

*Widworthy* and *Offwell*, between the *Otter* and the *Az*; and I had been particularly interested in this description, because the stone is there represented as being in large masses, which are buried under a soil of a very different nature, so that, when worked as quarries, they are soon exhausted. This is in itself a remarkable circumstance; but the more so as these quarries, not far from the *Blackdown hills*, are on masses of *lime-stone*; and it was very essential to know whether the latter contained *flints* of the kind which has here been our object. Having mentioned my wish to visit these spots to General Simcoe, he gave me an opportunity of doing it in the most advantageous manner, by writing to MR. TUCKER of *Coryton* near *Axminster*, a respectable magistrate of this county, who was so obliging as to call for me at *Ashfield*, and to conduct me, not only to the quarries, but to several places very remarkable in other respects; an excursion which I shall now proceed to relate.

*July 3d.* We set out from *Ashfield* at eleven o'clock; and Mr. Tucker first took me to *Honiton*, to call there on his uncle, the REV. MR. W. TUCKER, rector of the parish of *Widworthy*, who was so good as to accompany us thither in order to shew us the way to the quarries.

969. Beyond *Honiton*, we ascended the hills on the left bank of the *Otter*, opposite to those of *Blackdown*; and when we had reached their summit,  
Mr. W.

Mr. W. Tucker led us to a farm-house, where a well had been dug 105 feet in depth, by which has been gained a knowledge of the materials composing the mass of the hill down to that point. A very thick bed of white *flints*, different from those of the *Blackdown hills*, was first dug through, and below these lay *strata of loam*, that is to say, a reddish clay mixed with sand, containing a quantity of *marine bodies*; and no water was found, till the depth already mentioned was attained. Here then also are *flints* on *strata* which themselves contain none. Besides, we see a great difference between the *strata* of these hills, and those of *Blackdown*, on the opposite side of the valley of the *Otter*; for here the *strata* of *whet-stones* are not found and the *sand* is likewise of a very different nature. This is a proof that the *valley* was produced by repeated catastrophes of the *strata*; of which repetition new proofs will be seen in these same hills.

970. We crossed this ridge, and on the opposite slope, descending towards the valley of the *Ax*, we found the quarries which were our object. This whole side is also indented by *promontories*, and in the *combes* between these lie the quarries of white *lime-stone* mentioned by Mr Polwhele. We first went down to the *Offwell* quarries, where the appearance of the works soon shewed us the state of these *calcareous* masses. We were led by the workmen to the spot where Mr. Polwhele speaks of a quarry, the stone of which had been exhausted, after  
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it had been worked more than a century; we saw there a great excavation in the *loamy* strata on the side of the *combe*, but no trace of *lime-stone* remained. Coming afterwards to the place where they were then at work, we saw, in the section of the side of the *combe*, many pyramids of *lime-stone*, imbedded in the *strata* which form the mass of the hill. In one of the quarries, where the mass thus buried had been of considerable size, they had already come to an end of it on one side, where nothing remained but the *strata* of the hill; and they were expecting that the same would happen on the opposite side. The following is the account which the workmen gave us of these masses of lime-stone.

971. They could not have been discovered, had it not been for some projecting rocks of the same kind, in the sides of the *combes*, covered in part with moss, and become brown by the action of the air. The quarry-men begin by attacking these rocks, which they continue to work within the other *strata*. Sometimes they extract the whole mass; but, in other places, they abandon the quarry, before the stone is exhausted; because, as they are always obliged to remove the other *strata* above, which become thicker as they advance into the hill, it is attended with less expense to work other rocks: but, when none shall be left, the masses thus abandoned will be followed by galleries.

972. This

972. This stone appears to be only a hard *chalk*; it has all the whiteness of the *creta scriptoria*, but does not leave the same white marks: it is used for lime, being burnt on the spot with the Welch *culm*, of which I have already spoken. Beneath these *strata*, there are others of a different kind, rather less white, and mixed with so much sand, that the workmen call them *sand-stone*; they separate into flags, and are used for paving courts, halls, and kitchens: they make, however, a considerable effervescence with aqua fortis, as they participate in the nature of the *strata* which cover them. The masses of the *white stone* have their *strata* inclined in various directions, in different places; those of the quarry where we staid the longest descend inwards, having their section towards the *combe*: they contain large *chama*; so thin that they are broken as the stone is taken out, small fragments only remaining on their nuclei. It was for this reason, that, when I asked the workmen whether there were shells in the stone, they replied that they had never observed any; though, when we examined the masses broken for lime, we found a great number of these moulds of *chama*, retaining some parts of the shell, which had escaped their notice.

973. After having observed these quarries in the *combe* of *Offwell*, we crossed a promontory which separates it from that of *Widworthy*, where we found quarries opened in masses of *strata* exactly resembling the former, and covered in the same manner by the

the *strata* which form the mass of the hill; these contain the same species of *chamæ*; and we afterwards found similar masses in another hill at some distance. Hence is proved that, as I have said above, this whole country, or rather this part of the bottom of the ancient sea, has undergone many successive catastrophes: for these *calcareous strata*, the broken masses of which appear only here and there, being regular in each mass, and containing the same kind of shell, must have been formed successively in a continuous manner, on a part of the bottom of that sea, during a long period of its tranquillity. They were then broken by first catastrophes, and reduced to the state in which we at present find them: the great mass of new *strata* whercin they are now imbedded was produced over them by the sea itself; since we learn from the well sunk at the top of the hill that marine shells are contained in these new *strata*, which were afterwards subjected to that latest catastrophe whereby were produced the *vallies*, and the *combes* on the slopes of the hills, which shew on their sides the sections of their different kinds of *strata*; as will be everywhere seen in the course of this journey. These *white strata*, and those of *lyas*, some of which I shall soon have occasion to mention, are the only *calcareous* kinds in the country; no *flints* are contained in either of them; therefore the flints scattered on the *Blackdown hills* cannot, any more than the agates mentioned above, have belonged to any of the *strata* now existing in their neighbourhood, but must have been formed in *strata* anciently existing.

existing, which no cause in action since the birth of the continents has been capable of destroying.

974. From the quarries of *Widworthy* we ascended the hill beyond them, whence we had a view of an extensive tract of hills and vales, in a part of which Mr. Tucker the next day shewed me some very remarkable phenomena. I saw, in this space, the valley of the *Ax*, with the hills of its opposite bank; and on the west, two vales, the waters of which, being united, form the stream called *Westwaters*, already mentioned as joining the *Ax* below *Arminster*: it is chiefly composed of two small rivers, the *Yarte* and the *Cory*; and the vales of these are separated by a ridge of small hills. As we descended towards *Coryton*, we saw, near the bottom of the hill, strata of *marl*, forming alternate stripes of blue and red. These strata are found on the foot of many of the hills of this country, and are used for dressing the lands: in particular, Admiral Sir THOMES GRAVES shewed me strata of the same kind on the foot of the *Blackdown hills*, in a ramble which he was so good as to take with me the following year round his estate called *Woodbine hill*, near *Honiton*. The village of *Coryton* is situated at the point where the *Cory* joins the *Yarte*; above this stands Mr. Tucker's house, at which we arrived at four o'clock. I spent the rest of the day there, in a manner very agreeable to me, as well as useful; for besides that we had much conversation respecting the objects of my travels, Mr. Tucker, who, in the intervals of his public duties  
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relaxes his mind with amusing studies, has in his possession many physical instruments, and in particular a complete electrical apparatus.

*July 4th.* I set out from *Coryton House* with Mr. Tucker, in his one-horse chaise. His principal object this day was to make me observe a *combe*, the opposite sides of which consist of very different *strata*; thus proving as he had himself long thought; that *running waters* have not excavated the channels wherein we see them flow.

975. Being arrived at the bottom of the hill, we crossed the *Cory* on a bridge, whence we had a view of a great extent of meadows, this stream being joined by the *Yarte* a little below. Here Mr. Tucker told me, that one of the reasons which had always withheld him from acquiescing in the systems wherein, the running waters being supposed to have excavated the *vallies*, an immemorial antiquity must be ascribed to the *continents*, was that the streams flowing in *vallies*, so far from having excavated them, had every where, with a sensible progress, filled up the lowest parts with their sediments. "For example," said he, "it is a fact very well known, that this great tract of meadows was formerly nothing but a morass, which rendered the neighbouring country *aguish*; but that, the soil having been gradually raised by the sediments of the two rivers during their inundations, the marshes have thus been changed into good meadows, and the country has become very healthy."

976. Having

976. Having crossed both the rivers with their meadows, and gone some way up the vale of the *Yarte*, we entered the *combe* mentioned to me by Mr. Tucker, wherein the village of *Membury* is situated. A brook flows out of this *combe*, which however it evidently has not excavated, since it issues, already formed, from the foot of a rock in the lower part, where it immediately turns a mill. Though this water is very limpid at its source, it yet contains calcareous particles in dissolution, and is thus proper for the fertilization of the lands: it is carried along the foot of the hill by a channel, whence it is distributed in small rills over the meadows bordering the *Yarte*. Waters which issue thus impregnated with calcareous particles lose their fertilizing quality, if not immediately brought over the lands; for they abandon these particles, as soon as the gaz that has held them in dissolution is dissipated. I have seen, on slopes, meadows belonging to different proprietors, with springs of this kind issuing from the higher grounds: the water, being carried by gutters over the upper fields, had a very sensible effect in fertilizing them; but though afterwards transmitted to the fields below, it answered no farther purpose than to water them, and in some cases it even favoured the growth of bad herbage.

977. On the western side of this *combe*, which is that whence the brook issues, we saw quarries of the same nature as those of *Offwell* and *Widworthy*, with the same two species of *strata* lying one on the other,

other, the same *chamæ*, and no *flints*, although the same *white flints* are scattered on this side of the *combe*: here also the quarries are in masses of the *calcareous strata* buried in *loose soil*; these masses are likewise discovered by projecting rocks become brown and covered with moss; and their *strata* are seen to descend inwards beneath the loose *strata*. When however we had crossed the brook, and ascended the eastern side of the *combe* towards the hamlet of *Tolshays hill*, belonging to the parish of *Arminster*, we found there *strata* of *lyas*, a kind of lime-stone which prevails through a great part of *Somersetshire*.

978. It is in the upper part of this side of the *combe* that these *strata* are worked, because their *section* is there covered with only its own rubbish; whereas below there is a thick loose soil, consisting of other *strata*. Here the head workman of the quarry, who accompanied us, himself made the remark, that this upper *section* of the *lyas strata* must have been produced by a *fracture*, the masses detached from them being seen below. In order to prove this, he led us down the slope, where we saw many projecting rocks; and he told us that there were formerly more, which had been worked as quarries: these rocks are insulated in the loose soil, and their *strata* incline in various directions, according to the situations in which these masses happened to stop, in rolling towards the part where the rest had been swallowed up. Such was the idea formed by

by the workman himself; and no doubt of it can be entertained by any one who sees the place.

979. The principal quarry, as I have already said, is at the top of the slope, where the section of the *strata* has been easily cleared from the rubbish; it is very high, and is worked in steps, from the top downwards, for two purposes; the pieces which have remained, between the fractures, of sufficient size to serve as building stones, and for other uses, are laid aside; and the fragments are made into lime on the spot. I heard some explosions in the kilns, like the report of pistols; and when I inquired the cause of these, the workmen told me that they were occasioned by small masses of *mundic* (pyrites) which are in this stone.

980. This high section of the *strata of lyas* exhibits phenomena very opposite to many systems; and in the first place to that which has been so often repeated from BUFFON, and is also introduced into the Huttonian theory; namely, that the *calcareous strata* of our continents have been formed of the *detritus of marine bodies*, shells, corals, and madreporæ. The illusion very clearly appears in this spot, as well as in the whole district where the *lyas* prevails. The very idea of regular *strata* ought to have prevented such an hypothesis; for how should this *detritus*, carried about by the motions of the sea, have been deposited in *strata*, so exactly parallel to each other as these are, over such extensive tracts as  
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are occupied by the *lyas* in this country? And this remark is the more striking, as some of these *strata* are not above two inches in thickness, and none of them exceed seven inches. The difference of their colour likewise contradicts this notion of transportations by the agitated waters; they are for the most part blue; whence this kind of *lime-stone* is called *blue lyas*, (probably a corruption of *blue layers*;) but these are intermixed with grey strata, and with some which are almost white. This phenomenon cannot be any otherwise explained than by *precipitations* alternately suspended and recommenced, like the snows on high mountans; an explanation which agrees also with the very nature of the *strata*. There are quantities of small *marine shells*, very well preserved, *chama*, *cardia*, *pectines*, *ostreae*, *mytili*; but they lie principally on the surface of each *stratum*, an indication of suspensions, previous to the formation of new *strata*; and the matter in which these shells are imbedded is of a very fine and homogeneous grain.

981. Here I again found the phenomenon so contrary to the Huttonian hypothesis of the consolidation by *fusion* of the *stony strata*; and it is more striking in this instance than in many of those which I have formerly adduced, because of the thinness of the *strata*; they are all *calcareous*, but at intervals between the consolidated strata, there are some of *soft marl*, nearly of the same colour with the *lyas*; and as is the case with the latter, they vary in thickness,  
from

from two to seven inches. All these *strata*, which have their section in the side of the *combe*, descend into the interior part of the hill.

982. After these observations in the quarries, we ascended the hill on that side, where we saw a great extent of the ridge of small hills between the courses of the little rivers *Cory* and *Yarte*; and it was easy to perceive that these rivers had not excavated their vales; for in the ridge which separates them there are several wide intervals, but little raised above the level of the rivers. No cause, since the continent has existed, can have produced these divisions of the ridge, for they receive no water but that of the drops of rain; and after the description which I have given of the signs of catastrophes in the *strata* of this country, it is not difficult to find the real cause of all the sinuosities observed here, whatever be their depth and form. We returned hence to *Corydon* by the side of the *combe* on which is cut the channel of the brook that descends towards the meadows of the *Yarte*, and we crossed the great extent of those where the two rivers unite under the name of the *Westwaters*; these new soils have no longer any marshy appearance, the whole space now consisting of good meadow land.

*July 5th.* Mr. Tucker having been so kind as to propose to me a very interesting excursion, down the valley of the *Ax* to the sea, and thence by water, if the weather permitted, along the eastern coast as

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far as *Lyme*, he sent a servant early in the morning to Mr. HALLETT, one of his friends, who is the clergyman of *Armouth*, but resides at *Stidcombe*, a seat of his own, very near that place, and at the distance of five miles from *Coryton*, in order to acquaint him with our intention, and to request his assistance with regard to a boat. Mr. Hallett having returned a very obliging answer, we immediately set out in Mr. Tucker's one-horse chaise, the most convenient kind of carriage for the lanes of this country.

983. We crossed the *Ar* at *Arminster*, and thence proceeded along its left bank. On this road, Mr. Tucker first pointed out to me two ridges of hills, which come down on opposite sides, each from a distance of about two miles, towards the valley of the *Ar*, where they are cut off abruptly, and thus form the promontories fronting each other. The western ridge is called *Shute hill*; and that on the east *Musbury Castle*, on account of some traces of an intrenchment on its extremity, and of the village of *Musbury* situated in a neighbouring combe. Mr. Tucker here very justly remarked, that the small river *Ar*, which, when it covers the meadows at the bottom of the valley during floods, has but a very slow course, could not possibly have attacked the sides of the valley above and below these promontories, in such a degree as to widen those spaces to their present breadth, since, on the contrary it has raised their level by its sediments. The *valley* then must have existed at the time when the stream of  
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the *Ax* first took this course ; and the same proofs of the pre-existence of *vallies* to the course of running waters is found in almost all of them, when they are observed with attention.

984. Below the point where the valley is thus contracted, it becomes gradually wider down to the sea : and here Mr. Tucker himself had observed the change of the *marshes* into *meadows*. In the space which has been raised by the sediments of the *Cory* and the *Yarte*, this change had happened before his time ; because, as it is farther inland, the earthy particles brought down by the waters were there first deposited. But besides, another cause has acted near the sea, where the waves have raised a bar of gravel, which now extends from *Armouth* on the east, to *Seaton* on the west, leaving only a narrow passage for the *Ax* near the former of these small towns, for that reason called *Armouth*. After the formation of this bar, the space within was changed into a *marsh*, which, by degrees, has been converted into *meadows*. The change began in the parts nearer *Arminster*, because, as I have already said, the waters, during inundations, deposit the earthy particles as soon as they find wide spaces where they can spread, forming alluvial soils which gradually rise and advance forward ; and this has been the *progress* here observed by Mr. Tucker. As we resumed our conversation on this subject after our arrival at *Stidcombe*, Mr. Hallett, being older than Mr. Tucker, and living immediately on the spot, was able



to inform me of farther particulars : it is therefore on the authority of both these gentlemen that I shall give the history of what is now called here the *mouth* of the *river*.

985. It is evident that the lower part of the valley of the *Ax* has been a *gulph*, even within the memory of man ; or at least so recently, that this fact is attested by monuments of no great antiquity. Near *Seaton*, on the side opposite to *Armouth*, there are meadows which bear the name of *Merchant roads*, because, before the beach had extended itself on that side, the chief communication lay there of the *Ax* with the sea, and merchant ships passed that way to enter the port, which was then within ; and hence the small town on that side obtained the name of *Seaton*, a corruption of *Sea-town*. But since the bar of gravel has extended itself across this passage, the port has been removed to the outer side, on the strand, and is no longer of any importance, except to a very small district ; because large vessels cannot lie in safety on the outer coast. There were also some salt-pans near *Seaton*, into which the sea-water was brought in the spring, in order that it might evaporate sufficiently during the summer for the salt to be separated by boiling it in the autumn ; but this has been at an end, since the communication with the sea has been entirely interrupted. Higher up in the ancient gulph, the meadows, being improved, have been enclosed with dikes, or *walls*, as they are here called, to guard them against the inundations of the river ;  
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they are not exposed to any others; for, since the bar has been formed, the sea has ceased to have any sensible access within; but it still retards the running off of the land waters, and thus raises their level; a circumstance against which it is necessary to guard, in order that hay may be made in these meadows in summer, and that they may afford pasturage in autumn. For this purpose deep ditches have been dug, to carry the rain waters towards sluices in the dike; and in digging these ditches, pieces of anchors and parts of the rigging of ships have been found; whence it is manifest that vessels formerly came up here. Lastly, a part of the town of *Seaton* formerly bore the nickname of *Killpriest*, because the marshes rendered the air so unhealthy, that several clergymen died there; in consequence of which, the Bishops gave their successors leave to reside at *Beer*, a place at a small distance. But the soil of these marshes has been since raised by the sediments of the river; and the meadows which have succeeded them having besides been enclosed with dikes, the air in this place is now become salubrious. These are evident proofs that what is here called *Armouth*, is in the same case with the other places having the same termination which I have already described on this coast, both to the east and to the west; all these being only passages preserved for themselves by rivers through bars formed by the waves, which have thus closed the entrance of original gulphs, instead of having produced it by their action, as has been supposed in some geological systems.

tems. And here again, as well as along the whole course of the river, the progress of filling up, within known times, proves that the continent is not of very great antiquity.

986. *Stidcombe*, the name of Mr. Hallett's estate, is descriptive of its situation; for it is a *combe*, the aspect of which, to the geologist, clearly points out its origin, it being scattered with hillocks formed by masses of sunken *strata*, that remained higher than the rest in the general subsidence, and were afterwards covered with soft strata. Places of this nature are the most susceptible of improvement, as is the case here; for this scene of ancient chaos is now enlivened by beautiful meadows interspersed with woods. *Stidcombe* is the last of the *combes* in this ridge of hills; it is nearly parallel to the coast, and though large and deep near its opening, no stream passes through it, but a rivulet which is formed by springs. It will now be seen in what manner all the ridges of hills on this part of the coast are terminated towards the sea.

987, Mr. Hallett had been so good as to have in readiness his own boat, with a sail and oars, to carry us to observe the coast on the eastern side, and his eldest son, Mr. JOHN HALLETT, accompanied us as our pilot. Though the tides have little influence within this filled up gulph, because of the narrowness of the channel which the *Ax* has preserved through the high beach, the river itself is so small, that, in  
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common seasons, when the tide is out, the channel contains too little water for the passage even of a boat; it is necessary to wait for high water; and if the wind sets in from the sea, the moment of the turn of the tide must be taken, in order that its current may assist in going down the channel. We took this moment accordingly for our embarkation: there was little wind, but a strong surge was coming in towards the coast, which would have rendered our passage dangerous, if we had waited any later. Sometimes a wave entering the channel lifted us up, and drove us backward; then, after it had passed, we dipped rapidly forward, and had there been less water, the boat would have been split or upset on the gravel; but when we had gained the open sea, we had a very pleasant sailing.

988. When we had reached a certain distance from the coast, the cliffs became the principal object of our attention. We first observed here the same phenomenon which I have already mentioned at *Sidmouth*, § 765; this is, that the cliffs on the opposite sides of the entrance of the ancient gulph, being sections of the low hills bordering it, within, consist of the *red strata*; but as the cliffs rise, they become on both sides of different natures, being the sections of other ridges of hills. In those on the *Armouth* side, before which we passed, the *red strata*, after having continued horizontal to a certain extent, descend rapidly towards the east, and come down quite to the shore, where they terminate; beyond them

them appear, though within only a small space, strata of white *lime-stone*, like those of *Offwell* and *Widworthy*, which are seen also, in great disorder, on the upper part of the following hills, to the eastward; but there the cliffs become the section of *strata* of indurated *grey marl*, shewing no disposition to crumble down, because, they are homogeneous, and the interior waters do not break out through them: we passed very near the beach formed at their foot, consisting of siliceous gravel, and we did not see on it any masses of the marl, as would have been the case, had they been subject to demolition: I mention this circumstance, on account of the description which I shall now give of the state of the upper part of these hills.

989. As we went farther from the coast we discovered, behind the cliffs, some hills of a very picturesque appearance, advancing in several ridges, and separated by *combes*, all which have their names in the map; reckoning them towards the east, they are *Combpine*, *Whitlands*, and *Pinhay*. On the upper edges of these *combes* appear sections of the white *lime-stone*, and on their sides are many projecting rocks, probably of the same stone, but discoloured by the air, and overspread with mosses; in all other parts these *combes* are covered with grass; a proof that they have not been excavated since the continents have existed, the only waters which pass through them being those of the springs oozing from their sides, and the rains immediately falling in them,

them, and nourishing the grass. The ridges of hills that separate these *combes* do not reach the brow of the cliffs; their extremities are broken into small mounts, a consequence of the catastrophes which produced the *combes* themselves, and all these mounts are likewise covered with grass. The lower parts of the *combes* come down to the brow of the cliffs; and hence proceed small *rills*, formed by the springs. Here, therefore, we ought to find the verification of what is said by Mr. Playfair, (p. 369,) that “if we look at the smaller *streams*, we find them working their way through the *cliffs* at the present moment.” No such operation, however, is observed, either here, or on any other part of this coast: the *rills* issuing from these *combes*, when they reach the brow of the cliff, trickle down it, without effecting on it any change, except that produced in the colour by the mosses which overspread the part thus moistened.

990. The sea has not had more effect than the land-waters in producing the present aspect of this coast; for before it could have attained the *lime-stone strata*, which, as I have said, are seen in great disorder on the summits, it ought to have carried away the *strata* of *grey marl* forming the cliffs on the shore: but I have shewn above that there is no sign of demolition in the latter; which, no less than those of the hills behind, exhibit strong impressions of the latest catastrophes of all the *strata*, at the period when the present bed of the sea was formed. After continuing horizontal throughout certain spaces, these strata of indurated

indurated marl descend towards the east, with the same strong inclination as the *red strata* which had preceded them; and they terminate at the shore in the same manner. There is a great disorder in the cliff at the points where they begin to descend: after they have disappeared beneath the strand, they are again seen at their former height, and having continued for some way horizontal, they incline in the same direction as before, and come down to the level of the shore, where they again disappear; a change of situation which is many times repeated. This difference between the *strata* of the cliffs, and those of the hills rising behind them, is very common, and belongs to different kinds of *strata*; as I have shewn by examples, in §. 775, to the east of *Exmouth*, and in §. 554, in the bay of *Lyme*, whither we are now returning. Here, though at little distance eastward from the coast which I have just described, the *strata* of the cliffs are of a marl very different from that of the preceding, and the *strata* of the hills behind them, instead of being, like the former, of white *limestone*, are of *sand*.

991. We landed here behind the *Cob*, that strong curved pier raised at the entrance of the bay on the western side, for the purpose of forming a small port, by repelling the waves and the sand brought in by them. Hence we walked towards *Lyme* along the strand, which is here the place for bathing; and the tide being already out, we saw under the water, at various distances, several parallel ledges of rock, being the upper section

tion of *strata* dipping towards the sea. In my former description, §. 549, I had already mentioned this phenomenon, as beginning at the foot of the cliffs at the head of the bay ; and I had adduced it as a proof that these cliffs owe their origin to the subsidence of the *strata*, in the great revolution which has produced the present bed of the sea ; for these *ledges*, extending to a great distance, consist of the same *strata* of *indurated marl*, the sections of which are seen in the cliffs ; and thus, in their *subsidence*, they have assumed this *inclination* towards the space where the rest of the mass has disappeared. I again saw with regret the dangerous situation of the lower part of the town of *Lyme*, in the *combe* described, in my former visit to this place, as terminating within a promontory, where the *strata* of *marl*, softened by the springs flowing through them, often crumble down in the eastern part, because the sea comes up to their foot at high water, and its waves disperse the fallen materials. Since I was here, a wall has been built from the town to the *Cob* along the bathing place, in order to form a walk there. I hope that, as this port is very useful to a great extent of country, the ports of *Armouth* to the west and of *Charmouth* to the east having been long inaccessible, and as *Lyme* is more and more frequented also for sea-bathing, a greater work will be undertaken for the security of the eastern part of the town, on the plan which I pointed out in §. 552.



992. We re embarked at about four o'clock to return to *Armouth*; but when we arrived there, the tide was still low, and there was not sufficient water in the *Ar* to allow our boat to enter: we landed therefore on the strand, and followed this small stream across the beach, within which I saw it flowing on a bed of gravel covered with aquatic plants; a proof that, notwithstanding its inundations, it does not excavate this bed. But where it crosses the beach, the case is different; for I was told by Mr. Hallett, that sometimes, after a long continuance of high winds from the south-east, a part of this bank was carried away, and its gravel dispersed around over the bottom of the sea; but that, with the first strong south-westerly wind, the waves brought it back; when, if the *Ar* happened to be low, it entirely closed the *mouth* of that river, which discharged itself only by filtrating through the gravel, till it was again sufficiently swelled by rains to open a new channel. The place, however, since I observed it, has been guarded against this effect of the sea. I have lately heard that Mr. John Hallett, who was so good as to be our pilot in this little voyage, has secured a passage for boats in all seasons, by forming a permanent channel for the *Ar* across the beach, and defending it against the action of the sea by a *cobb* like that at *Lyme*; a method which I saw afterwards employed in other places. Thus every thing concurs in proving the small antiquity of the human race itself, as well as that of the continents which it at present inhabits. In proportion as men find that

any inconvenience arises to them from the progress of the effects of natural causes, their industry supplies them with the means of obviating those effects. This is a subject into which I entered, with many details, in my *Lettres sur l'Histoire de la Terre et de l'Homme*, where I described, in various respects, the progress of human industry, in mountains, along rivers, and on the sea-shores.

993. It was near five o'clock when we returned to *Stidcombe*, where I passed the evening in a manner very satisfactory to me, talking over the various objects of my observations with very intelligent and obliging men. Mr. Hallett was so good as to make arrangements for my departure on the following morning, by engaging for me a boat with a sail and oars, to carry me by sea to *Budleigh Salterton*, near the mouth of the *Otter*; to which place I had been invited by General Siincoe.

*July 6th.* Mr. Tucker had again the kindness to accompany me as far as *Seaton*, where I was to embark; for he wished to point out to me several interesting objects in the road across the opening of the ancient gulph. The bar of gravel closing this opening is very wide and high on the *Seaton* side, where, as well as on that of *Armouth*, it passes along the cliffs of the *red strata*, which border the white *calcareous strata*. In the beach itself, some way before we came to *Seaton*, Mr. Tucker shewed me a hillock of the *red strata* that had evidently been an  
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island at the entrance of the gulph, before the beach had been formed around it. This is a phenomenon similar to many others which I have already pointed out in situations of the same kind, as shewing that the bars of gravel formed at the entrance of so many gulphs have resulted from submarine ledges, consisting of parts of the *strata* which remained higher than those that subsided below the present bed of the sea. The situation of this mass indicates that the *red strata* occupied the whole of the space, which, by their subsidence between the parts forming the low hills on both sides, became a gulph; and that the bar of gravel has been occasioned by a ledge of these *strata* remaining higher than the rest, though in no part above the surface of the sea, except where we now see the hillock.

994. We then went down from the beach upon the meadows within on the *Seaton* side, which occupy the place of the gulph, along the right bank of the *Ar*. Mr. Tucker told me that it was about fifty years since that part of them which, being raised above the common level of inundations, was but seldom flooded, had been enclosed with dikes, in order to secure it entirely. The operation was carried on in the same manner as was used by the ancient inhabitants of the *marshes* in *Holstein* and *Sleswigh*, a deep canal being dug along the firmest part of the meadows, and the earth taken out of it thrown up on its outer edge to form the dike; on the outside of which were left what are called *fore-lands* in the above-mentioned countries

tries ; that is to say, soils not yet sufficiently firm, but continuing to be raised by fresh sediments. After this, drains were cut in the space within the dike, to conduct the rain-water into the canal, whence it is discharged by a sluice. This operation, which, as I have explained, proved ineffectual on the above-mentioned coast, has been here sufficient, as there is no longer any thing to be apprehended from the sea.

995. I have already said that the port of *Seaton* is now at the outer side of the beach, on the open coast ; I embarked there at eleven o'clock, taking leave with great regret of Mr. Tucker, to whom I had been so much obliged, and for whom I shall always retain a very sincere esteem. The weather was fine, and I had a most agreeable voyage ; only the direction of the wind did not permit us to sail very near the coast. Mr. Polwhele, in his *History of Devonshire*, Vol. I. p. 65, describes the quarries of *lime-stone* which are worked, as well on the hills as near the coast, between *Seaton* and *Sidmouth*. This stone is nearly as white as chalk, and thus resembles that of *Offwell* and *Widworthy* ; but it is harder and less fractured, so that it is used for building : Mr. Polwhele, however, speaks of one *stratum* which contains blackish flints ; and this, as well as the form of the hills, indicates that the *strata* are much disordered.

996. It

996. It may have been seen in my preceding travels that, from the bay of *Weymouth* as far as *Armouth*, the hills of *chalk* and *white lime-stone* of a similar nature, which prevail throughout a great extent of the south of *England*, do not come down to the coast; they appear only in the eminences more or less distant, and the hills forming the cliffs towards the sea are composed of *strata* of other species, which I have successively described: but from *Seuton* nearly to *Sidmouth*, the cliffs, except in the immediate vicinity of those two places, where they consist of *red strata*, as has been already mentioned, are composed of the *white strata*: these begin at the point called *White cliff*, and continue without interruption to the cape of *Beer head*, beyond which opens a large combe, wherein is situated the village of *Beer*, and whence a brook issues. It is chiefly around this cape, on account of the easy transportation by sea, that quarries have been opened on this lime-stone, which is known in the country by the name of *Beer-stone*: these hard *strata* are the same that are seen to form the base of those of *chalk*, from *Salisbury* to the eastern coast, wherever that base is uncovered at the foot of the hills; they are constantly without *flints*, and are more or less indurated in different places. On this coast also, the highest of the white *strata* approach the most nearly to the nature of *chalk*; upon these lie *reddish strata*, which are succeeded by *grey* ones. All these kinds of *strata*, by their sections at different heights, with grassy slopes beneath, form towards the sea an amphitheatre, which,

which, at the same time that it exhibits a very singular aspect, shews in what manner they were broken off at the time of the formation of the present bed of the sea.

997. Beyond *Beer*, the top of the cliffs recedes more and more from the sea, in consequence of the same operation which is everywhere tending to obliterate those features of the coast; they crumble down, and wherever the materials descending from them have repelled the sea to such a distance, that they are no longer liable to be carried away by its actions, a strand is formed, and the materials, still continuing to fall from above, rise up against the cliff; and are covered with plants. Near *Beer*, this operation is not yet far advanced; but there are spots in which vegetation begins to appear, though the greatest part of the section of the *strata* is still left bare; these *strata* are of different colours; so that, in sailing at some distance from the coast, while the sun was shining on the cliffs, it seemed as if all this part of them, which is of great extent, had been hung with a piece of striped silk, embroidered with green in an irregular pattern. Farther to the westward, the slope is entirely covered with grass, and a beach of considerable height follows its foot.

998. To the west of the *combe* of *Beer*, there are three other principal *combes*, *Branscomb*, *Dunscumb*, and *Salcomb Regis* near *Sidmouth*. These begin at a great height in the hills, and descend towards the

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sea:

sea : that of *Branscomb*, from which a brook issues, comes down quite to the shore, where it is much contracted, though very wide in the upper part. The two other *combes* are, on the contrary, wider at the bottom than towards the top, and form only indentations in the cliff at different heights ; it appeared to me that the rills proceeding from them issued through fractures in the cliff. All the upper part of these *combes* shews an open section of the strata of *white lime-stone*, which are worked in various places up to the eminence dividing *Salcomb* from the gulph of *Sidmouth* ; but there they cease ; for the slope towards that gulph consists of lower hills of the *red strata*, which continue to border it on the western side, where the *white lime-stone* appears no more ; a strong symptom of the catastrophe that produced this great excavation in the lands.

999. There are few prospects more interesting than that of this gulph, when viewed from the sea, in fine weather, and at such a distance as we were kept by the wind. In the centre of this wide opening appears the town of *Sidmouth*, the access of which to the sea is entirely cut off by the bar of gravel, as I explained in the preceding volume, §. 767 ; and the gulph is encompassed by the cheerful cultivated hills, through a lateral opening in which arrives the little *Sid* to lose itself in the gravel. The entrance of the gulph is singularly marked by the cliffs on both sides, consisting of the *red strata*, and forming a contrast with the verdure within : these strata, on the right  
side

(as viewed from the sea), descend towards the east, where they pass under those of *white lime-stone*, and thus disappear; hence it is evident that the latter must have been originally deposited on the former; and that, in the great subsidence whence the gulph has resulted, all the *strata* must have been strangely convulsed; for those of the *white lime-stone*, besides that they also are inclined on the eastern side, have totally disappeared on the western, where the cliffs of the *red strata* continue from *Sidmouth* to the mouth of the *Otter*. In these there is the singular phenomenon of *Larderum cove* which I described, §. 762; and in sailing along this part of the coast, I observed many other recesses equally picturesque. The sea is here very deep, for I saw no permanent strand, except in these coves; that which is forming at the foot of the cliffs being still covered at high water.

1000. The village of *Budleigh Salterton*, whither I was going, is situated beyond the mouth of the *Otter*: I arrived there at three o'clock, but General *Simcoe* was gone out, and was not to return till the evening; I therefore employed the remainder of this fine day in an excursion which I had occasion to make in the neighbourhood. I had written from *Ashfield* to request my worthy friend Mr. *Short of Teignmouth* to engage for me an one-horse chaise, for the long tour which I purposed to make through *Devonshire* into *Cornwall*, and to send it to meet me at *Ottertton*, whence I also intended to observe



the course of the *Otter* down to the sea: I had received his answer, to inform me that the chaise should be with me as I had appointed; and at the same time he had been so good as to send me a letter of recommendation to Mr. SHORE, the clergyman of *Otterton*, a brother of Lord Teignmouth's, in which he explained to him what were my particular views: it was therefore on account of both these objects that I went to that place.

1001. I set out on foot for *Otterton*, it being only three miles distant from *Budleigh Salterton*. In walking along the western side of the meadows traversed by the *Otter*, I saw, at the first glance, that all this part had formerly been a gulph; a bar of gravel formed at the entrance still leaving behind it a space of water, where terminate these perfectly horizontal meadows, extending on both sides of the river as far as the foot of the hills. On arriving at *Otterton*, I found the chaise, and was pleased with the appearance and discourse of the driver, who proved extremely useful to me throughout my journey; being not only very intelligent, but likewise perfectly acquainted with the country through which I travelled, and even knowing most of the gentlemen to whom I had recommendations. After having made some acquaintance with my future guide, I called on Mr. Shore, who received me with great politeness: from him I learnt many particulars concerning the course of the *Otter* above the space where I wished to observe it; and before I describe that space, I shall

shall give an account of the river from its origin, adding to Mr. Shore's information that which I afterwards received from the REV. MR. LUTHER ELLIOTT, who lives at *Salviston* near *Ottery St. Mary*, and is brother to Mrs. A. Elliott, the friend and neighbour of Mrs. Burges.

1002. The *Otter* is one of the rivers which shew the most evidently that they have not excavated any part of the large spaces whercin they flow. I have already said that it rises in a valley, the sides of which differ greatly from each other: on its left bank are the hills with the strata of *lyas*, that pass on to *Membury*, where I have lately described them, a mass of the same strata appearing also on the right bank, at the extremity of the *Blackdown hills*, which the river follows some way below *Honiton*. This part being intersected with so many branches of hills, the *Otter* is here too much confined to have left any great quantity of sediments; there are only a few small meadows at intervals: but after it has quitted the *Blackdown hills* in its way towards *Ottery St. Mary*, it enters an extensive tract of meadows, where it is joined by the *Tale*, another small river. Mr. L. Elliott has observed that these meadows are rising sensibly by the inundations of the rivers, the grass retaining the earthy particles carried along by the water which overspreads them; and he told me the following remarkable circumstance. As the whole of this soil is not under water during common inundations, the parts at such times flooded have received  
a greater

a greater quantity of sediments than the rest ; so that the soil of the most distant meadows is lower than the usual bed of the river itself. I have observed this to be also the case in some parts of the course of the *Po*, through the plains of *Lombardy*. But below *Ottery St. Mary*, the course of the *Otter* becomes more rapid ; and when it overflows, it attacks some parts of its banks, till it arrives within a certain distance of *Otterton*, where it again passes through horizontal meadows. Advantage has been taken of the higher level of the river above, to cut a channel along the foot of the hills on one side, by which a part of it is conveyed to turn some mills near *Otterton* ; its common bed being reserved to carry off the water during floods, when it still overflows its meadows to a greater or less extent, in proportion to its abundance.

1003. Such is the course of the *Otter*, from its rise to *Otterton*, where it entered originally into a *gulph*. It would be difficult at present to determine at what point this river arrived at the level of the sea, because the difference of level is insensible between the meadows which cover the bottom of this extremity of its valley, and those which certainly occupy the place of the ancient gulph, whither Mr. Shore was so good as to conduct me. On the *Otterton* side, the river has preserved its course along the foot of the high hills, which, in the *gulph* itself, form cliffs that are prolonged into the sea : the water was low when we observed it, flowing much below the level

of the meadows ; so that, on the sides of the channel, we could perceive their soil to be composed of the sediments of the river and sea-sand. The opposite side of this ancient *gulph* is very different ; the original soil is there low ; and it extends in a gentle declivity under the sediments, which, on its border, are a little higher than the rest of the meadows ; and on this part, the spring waters proceeding from the grounds above are retained in a trench, whence they are turned over the meadows in dry seasons ; by which means the grass is mown there twice a year, and yields afterwards a rich pasturage.

1004. The subsidence which produced this gulph has left here a monument similar to that at *Seaton* ; namely a mass of the *red strata*, called the *Granary*, and large enough to be marked in some of the maps : this mass had remained above the level of the water at the entrance of the gulph, but is now enclosed in the bar of gravel, which has been probably formed on a ledge of the same strata, and which, beginning from the western side, has almost entirely separated the gulph from the sea : a channel left on the eastern side now forms the *mouth* of the *Otter*, and serves for the discharge of its waters ; but only during the reflux, for the tides rise up this channel, and extend themselves to a great distance within, filling the ditches of the meadows by which the rain and spring waters run off. This effect was at that time very evident ; for the tide being high, we could not walk on to the end of the meadows, because the ditches were too full

full of water to allow us easily to step over them. We then crossed to the right bank, which, as I have said, is higher.

1005. Having continued to follow this bank, we came to the point where the meadows terminate in a marsh, near the space of water enclosed by the beach; and I saw several narrow slips, covered with grass, extending from the extremity of this new soil between the outlets of the ditches of the meadows, on the sides of which are deposited the earthy particles brought along by their waters. I asked Mr. Shore whether these slips of land made any progress; he told me that he had not resided long enough in the country to have observed it; but happening to see before us Mr. COCKERAM, the proprietor of a part of these lands, we hastened to overtake him: Mr. Shore, accosting him, requested that he would answer my question; and from him I obtained the following details. These slips of land are continually advancing forward in the space still occupied by the water, and at the same time the intervals between them are filling up. The tides, rising over these grounds, and running off towards the ditches slowly, and only at the surface, deposite on them the mud which they have brought up; this raises the soil of the marsh, and by degrees converts it into good meadow-land. "This progress," continued Mr. Cockeram, "has been very sensible since I have observed it; the space of water within the beach has visibly been much filled up, and there

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“ is no doubt that at last it will disappear.” Thus the same succession of natural effects takes place here, as in all gulphs, and on all coasts ; and while these effects demonstrate that the sea has not occupied its present bed during any very great number of ages, the perfect horizontality of all these new soils, not only on the coasts of *Great Britain*, but around every part of the continents, evidently shows that, since the time of their commencement, no change has any where occurred in the *relative level* of the *lands* and the *sea*, except indeed, on such coasts as have volcanoes near them, as is the case with that of the kingdom of *Naples*. After having observed this extremity of the gulph, we went back to *Ottertton*, where I staid a little while with Mr. Shore ; then, very thankful for his kindness, I got into the chaise which had met me there, and returned to *Budleigh Salterton*, where I found General Simcoe, with his amiable family.

*July 7th.* General Simcoe was so good as to show me the neighbourhood of *Budleigh*. There is scarcely any place near the coasts, which does not present phenomena of some importance with respect to the history of the continents : I met with many here of various kinds ; but I shall confine myself to the most essential.

1006. *Budleigh Salterton* is situated at the lower part of a *combe*, in the front of which is formed a beach of considerable extent, consisting of rounded lenticular

lenticular fragments of a stone belonging to the class of the schisti, whereof is composed also the gravel wherewith the top of these hills is covered ; a rivulet issuing from this combe filtrates through the beach and is lost there. This beach is continued along the cliffs which border the coast, and extend first southwards, but afterwards turn to the west. These cliffs manifestly show the catastrophe whereby the *combe* was formed ; for in the first place, their *strata*, from the most elevated point which is about 7 or 800 feet in height, descend on the side towards *Budleigh*, and pass successively under the level of the strand. Other characters of catastrophes are shown by fractures from the top to the bottom of the cliffs, on the opposite sides of which the *strata*, very distinct by their differences in colour and composition, have changed as much as five feet in their relative level being, at these points, lowest, on the side where they rise towards the highest part of the cliff ; so that, in following the strand in the direction of the descent, some of them, which had already come down to it, are seen five feet above its level beyond the fracture, and then again descend in the same direction ; and this is repeated many times. These fractures must run across the whole hill ; for they intersect the course of the spring-waters within, through which they afford an issue on the shore ; and the catastrophes must also have extended to the whole mass of the interior *strata*, since otherwise these changes of level could not have taken place in the exterior. This remark must be applied to all the changes

changes of relative level which are observed in the *strata*, on the opposite sides of *fractures*.

1007. There are in this cliff some *strata* which present a phenomenon concerning *gravel*, similar to that already described (§ 620) in the *Isle of Wight*; but there it could be seen only near the surface; whereas, in the *Budleigh* cliff, it begins much lower, and several repetitions of it, at considerable vertical distances, are exposed to view. This cliff exhibits the section of all the *strata*, down to the level of the sea, or the strand. At the top appears a bed of *gravel*, of the same kind which composes the beach; this bed forms the surface of the hills, and is of various degrees of thickness in different parts: immediately below it, lie very regular *strata* of sand mixed with clay; and these are the *strata*, of different colours, parallel with each other, and forming a large mass, which, beginning from the highest part of the cliff, and descending towards the *combe* of *Budleigh*, come down to the shore near that *combe*. Below this mass of regular *strata* is a *bed of gravel*, the first of those now under consideration, the *section* of which very much resembles the festooned drapery of a handsome apartment, fastened up with cords at certain distances. In the part where the cliff is highest, appear several of these *beds*, separated by a greater or smaller number of regular *strata* without gravel: they are in some places not less than fifteen feet in thickness, from which they diminish on both sides to about one foot; afterwards they swell, and are again  
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long observation alone can assist us to decypher: of this kind I shall describe some other very striking monuments in the course of these Travels.

1009. The beach along the foot of the cliffs above mentioned being composed, for the most part, only of the gravel falling from the top, (because that of the lower strata breaks as it falls, and is washed away,) this beach is not yet sufficiently high, along a great part of its extent, to prevent the waves from reaching the foot of the cliffs at high water; and thus their demolition is prolonged. This demolition originates in the fissures formed in the hill, near its brow, by alternations of moisture and drought; and the water which in autumn insinuates itself into these crevices being frozen in winter, the effort of its increase of bulk is directed towards the exterior side, which is without support; so that sometimes in the spring, as General Simcoe told me, pieces fall, several feet in thickness, and extending vertically almost from the top to the bottom of the cliff. It is here evident, that demolitions of this kind are produced by land-waters, and not by the sea; but the sea occasions their continuance, as I have repeatedly explained, by preventing that accumulation at the foot of the cliffs, whereby degradations are everywhere terminated. When masses of the strata have here fallen on the strand, the waves of the high tides wash away the sand, which is carried along by the currents, and deposited in recesses of the coast; the gravel then alone remains, and is driven by the  
waves

waves against the foot of the cliffs; but it has not yet been accumulated in a sufficient quantity to guard them against the actions of the sea: this effect, however, will in time be produced, and the beach will acquire sufficient breadth to permit the materials still falling on it to rise against the cliffs in the form of a slope, which will then be overspread with vegetation. This operation has already taken place on the part of the coast that turns to the west, where it was originally less high; and its foot not being so directly attacked by the waves of the east wind, the beach is there become wider, and the cliff, reduced into a slope, is covered with grass. General Simcoe was so good as to take me to some other spots in the neighbourhood, where every thing indicates the same catastrophes in the production of the *combe* and all its branches; but the circumstantial account which I have already given may suffice for this place.

*July 8th.* In the morning I set out from *Budleigh* in my chaise, to go to *Teignmouth* over the hills bordering the sea. In quitting *Budleigh*, I ascended a branch of the *combe*, which at first follows the direction of the high cliff. I thus arrived at the top of the hill, where the disorder of the *strata* in its mass, already shewn by the ruptures and unequal subsidences observed in the cliff, is also indicated by the aspect of the surface, consisting entirely of hollows and hillocks; the latter are covered with heath; but the hollows are grassy, because the rain water

lies there longer. A branch of the hills over which I afterwards passed is separated by a large *combe* from another branch, which forms the cliffs by the sea-shore, and extends all the way to *Exmouth*. As I had already observed this gulph, I only crossed it, first passing over the the channel of the *Ex*, and then proceeding along the bar of sand which I have before described, whence I ascended the hills on the western side.

1010. I followed these hills as near the coast as possible, intending to stop at *Dawlish*. For a long time, I had on my right a large *combe*, which descends towards the gulph of *Exmouth*, and of which the lower part, being very wide, is covered with meadows. I have since learnt, that, within a known period, ships have entered, at high water, a considerable way up this creek of the gulph; but that the sediments of the tides having gradually filled it up, the new soil, being covered with grass and converted into meadows, has been secured by a dike against the spring tides, the brook which issues from the *combe* running off by a sluice at low water. The ridge of hills separating the gulph of *Exmouth* from the small gulph of *Dawlish* is very high; so that, after a long ascent from the former gulph, there is an equal descent to the latter. My road afforded me a constant view of the sea; and I observed that within the greater part of this space, the cliffs along the coast were formed by low hills consisting of the *red strata*. The hill above is of a soil quite different, and is covered with the same gravel of  
*grey*

*grey wacke* as the eminences which are on the eastern side of *Exmouth*; only there are here more *flints* mingled with this gravel.

1011. I had already the pleasure of being acquainted with Sir WILLIAM WATSON, a man of great knowledge in the natural sciences; and I had heard of the very singular manner in which he had converted a part of the cliff at *Dawlish* into a pleasure-ground. I went immediately to his house, built on the eastern side of the gulph, and I had the good fortune to find him at home. In this spot may be seen what metamorphoses genius and taste can produce in grounds possessing no natural beauty but that of situation: *Dawlish* stands near the sea, in a recess of the coast formed by the lower part of a large *combe*, which has many ramifications rising among the hills to a great distance, the village of *Ashcombe* lying in the most remote part: a small brook, formed by the springs in these various branches of the *combe*, discharges itself into the sea, by filtrating through a beach which the waves have raised across the entrance of a small original gulph, now transformed into meadows; and the hills that encompass it are scattered with trees.

1012. Sir William Watson, having been pleased with this spot, bought a field, some years ago, on the slope of the eastern hill, situated on the brow of the cliff composed of *red strata* unequal in hardness; a state, however, which is not perceived till their section in the cliff has been long exposed to the  
actions

actions of the air, when the softest parts being the most corroded, the others remain in relief, exhibiting a very singular appearance ; and this circumstance, in addition to the different accidents which happened in the catastrophe whence the cliff resulted, renders it altogether a most grotesque object. Sir William comprehended what advantage might be taken of these natural peculiarities ; and being in possession of the field, which had hitherto been cultivated only in a loose soil of little depth, he set to work upon it, in the same manner as a statuary undertakes to give to a large block whatever form his genius suggests to him. He lowered the surface of the hill along the cliff, leaving a sufficient thickness on the brow of the latter to serve as a wall, sheltering against the sea winds the space within, which is converted into a garden : the wall is covered with shrubs, except where some apertures with shutters have been made, to give a view of the sea. But one part of this natural wall has been left of sufficient thickness to be hollowed out into a small apartment, well lighted towards the sea with strong glass windows ; and Sir William, having intended this for his study, has fitted it up in the most agreeable manner, with niches scooped out in the sides for books, various instruments, and busts. The cavity, being in the rock, exposed to the air on every side, is very dry : and the thickness of its natural walls being great, an almost equal temperature is preserved in the apartment within, as there is in caverns. This piece of ground being on the slope of the hill towards

the inner part of the gulph, a winding path down its declivity offers various beautiful points of view. The house, which is built near the upper part in the form of a Gothic castle, harmonizes with the romantic scenery around, more than is commonly the case with buildings of that kind in other situations. A large portico before the principal front was adorned with lemon-trees in tubs, loaded at once with lemons nearly ripe, with others which would arrive at that state the following season, and with flowers preparing fruit for the third year. Sir William, being a botanist, has obtained and prepared, in working on his vast block, such aspects and soils as are proper for many exotic plants, which he has here naturalized, from the alpine kinds to those of the Cape; for this coast enjoys a very mild climate; and these plantations, cut into very pleasant walks, present an interesting variety of trees and shrubs. In a word, I could not have passed the little time I had to spare more agreeably than at *Darlish*, especially since it was by no means unprofitably spent with respect to Geology.

1013. In conversing on the latter subject, Sir William Watson told me, that his own observations on the cliffs of this coast had fully accounted to him, as well for the intersections found in these cliffs, as for the vales and combes coming down to them, without any necessity of having recourse to the evidently inadequate cause of the waters which flow in in them; since, on the contrary, the sediments of those

those waters, together with the materials impelled by the waves and deposited by the tides, every where tend to fill up such openings towards the sea; while, at the same time, all these openings, as well as the cavities of the vales, bear evident characters of catastrophes. As I had but very little farther to go to reach *Teignmouth*, Sir William offered to lead me to the adjacent coast, in order to show me some of the objects which, in these various respects, he thought the most striking.

1014. Going down towards the entrance of the small gulph, he first made me observe the beach which crosses it, extending on both sides under the cliffs, and serving as a dike to the small horizontal meadows, through which flows the little brook that descends from the combes, and loses itself in this beach. This Sir William with reason considered as a proof, that neither the waters of the land nor those of the sea had produced the great *intersection* here found in the cliffs, and extending so far inland, under the form of the many great *combes* branching upwards from this point.

1015. We passed afterwards under the eastern cliffs, which present a very singular aspect: their mass consists of the *red strata*; those at the level of the sea, the lowest consequently that can be observed, are breccias, containing not only gravel, mostly angular, but large masses of *grey wacke*, with some fragments of *flint*. *Strata* of these  
 G 2 breccias



breccias recur several times in the height of the cliff, while no gravel is contained in the intermediate *strata*; the latter are likewise indurated, and besides they are penetrated by harder laminæ of a ferruginous substance, which is so regularly disposed within, that, in consequence of the erosion of the softer parts, the surface, from a distance, looks like a honey-comb; and when viewed nearer, has the appearance of the side of a large pigeon-house. These *strata*, the section of which forms several terraces on the side next *Dawlish*, are rapidly inclined towards the opposite side, as is seen in the cliff, where they pass successively under the strand. Proceeding eastward, we found the cliffs again interrupted by a kind of *combe* sloping down to the coast, wherein the masses of *strata* are in a chaos which no cause can have produced since the continent has existed. It was from these different phenomena, observed in many places, along the coasts, and in the vales and combes descending to them, that Sir William Watson had concluded, as will be the case with all those who shall attentively study such objects, that all the great channels by which the waters flow through the lands, and arrive at the sea, had been formed, previously to the birth of the continent, by the catastrophes of the *strata*.

1016. I quitted *Dawlish* with regret; but my worthy friend Mr. Short expected me early at *Teignmouth*, and I wished to observe the cliffs at the entrance of that gulph. I arrived there at five  
o'clock

o'clock; and Mr. Short, judging that the tide, though then ascending, would still permit us to walk some way along the shore, proposed that we should take this opportunity of observing the cliffs on the N. E. side; and accordingly we immediately set out.

1017. These cliffs likewise consist of the *red strata*, and from a distance, they have the same aspect as those at *Dawlish*; but, when viewed near, a considerable difference is observed in their composition: they are intermixed, indeed, with hard *strata*, either pure, or in *breccias*; but the former are not intersected by the harder laminæ, which, by the erosion of the softer parts, give to those of *Dawlish* the resemblance to a pigeon-house. Here begins a phenomenon, of which the particulars will, in the sequel, become more and more interesting. Some of the *strata* of the *breccias* contain, among the gravel of *grey wacke*, the fragments of a *whitish limestone*, which I did not immediately recognize, because the first of these extraneous masses that I tried with aqua fortis made no effervescence; but that effect was afterwards produced by others; and the phenomenon of *calcareous* masses disseminated in a part of the country, where no *strata* of this *limestone* appear, will add a new character to the strange catastrophes of the *strata*.

1018. We walked along some way under this cliff, observing the situation of the *strata*: within a certain space, they appeared, on the side next the sea, to be horizontal,

gone a change: in the parts newly broken, these are seen to be penetrated, to the depth of about a quarter of an inch, with a greenish tinge, the inner part remaining grey. This is a very surprizing mixture of stones of different kinds, of which there are no *strata* in all the neighbouring country; and besides, they are here imbedded in *breccias*, between other *strata* containing none. In the sequel, different examples of the same phenomenon will appear in the interior part of the country, which will increase the variety of our documents respecting the *history* of the *ancient sea*, and fill up some vacancies in the details of that history, the great features of which are however already very evident.

1021. After these observations, I took leave of Mr. Short, whom I was to meet again in a few days, and continued my journey. I have already described the road from *Shaldon* to *Torbay*, passing along the upper edge of the remarkable bay of *Babicombe*; I did not go down to either of these bays, having before observed both; but proceeding on my way over the small hills encompassing the former, I came on that higher ridge, where is the singular association of *calcareous* and *schistose* hills, which I have also described in my preceding journey. Hence I descended to *Kingswear*; and crossing the gulph, I arrived at *Dartmouth* at about five o'clock. Here I had the pleasure of finding Mr. Rockett, at whose house I passed the evening; he was so good as to give directions to my driver with respect to our road to

to Mr. Adams's seat at *Bowden*, over the hills bordering the western side of the long gulph into which the *Dart* enters at *Totness*; and at the same time he described to me the *combes* that I should cross, and their connexions with the branches of this *gulph* forming the æstuaries which we had observed in passing before them in a boat the preceding year.

*July 11th.* I set out from *Dartmouth* at eight in the morning, taking the road towards the hills by the *combe* leading to *Townstall* and *Norton*, at the bottom of which is the new dock, mentioned in my former journey. As I ascended this *combe*, I saw in its sides that the base of this part of the hills consists of *schisti*, which are buried under a great thickness of the *red strata*, becoming *grey* near the top.

1022. When I came upon the hills, after travelling for some time northwards, I arrived at a second large *combe*, terminating in the æstuary of *Dittisham*, before which I had passed the preceding year. I had a long descent towards the bottom of this *combe*, here equal in breadth to that part of the gulph of the *Dart* which it joins; yet the only water passing through it is a brook formed by the springs issuing from the sides of its several ramifications: some small meadows have been formed on the sediments of the rivulets which feed this brook, at the points where they enter the principal *combe*; and in the lower part of the latter, where it joins the æstuary, the meadows are very extensive. A single piece of  
lime-stone

lime-stone serves as a bridge across the brook in these meadows, and is wide enough to be passed over by carriages. The *schisti* are again seen at the bottom of both the slopes; and it is a remarkable circumstance that, in the long slope which I descended into the combe, the upper *strata* are *grey*, and in the slope, also very long, which I ascended on the opposite side, they are *red*.

1023. I proceeded some way on the top of the hills, and then descended into a third large *combe*, by a slope consisting of *grey strata*, like the former slope turned in the same direction. At the bottom of this *combe* is an æstuary, on the south of which is the village of *Cornworthy*, and on the north, that of *Ashprington*. This *combe*, very wide in the upper part, is contracted in the lower, where its bottom is covered with meadows, traversed by a rivulet. On the *Cornworthy* side is a village called *Tuckney*, with a port situated near the entrance of the æstuary. Here are several lime-kilns on a promontory, though, on this western side of the gulph of the *Dart*, there is no *lime-stone* below *Sharpham*; but this port is very convenient for landing the *lime-stone* brought from the quarries of *Gampton*, on the eastern side, and the *culm* from *Wales*, with which it is burnt, as well as for shipping the lime, that it may be transported wherever it is wanted. The ridge of *lime-stone* hills extending across this part of the country has been obliquely intersected by the subsidence which has formed this long gulph; an abrupt hill  
 belonging

belonging to it appears on the western side, at *Sharp-ham*, and on the eastern, beginning at *Gampton*, some way below, it terminates towards the sea at *Berry head*.

1024. I crossed the rivulet of this combe at *Tuckney bridge*; beyond which I passed, at *Bow bridge*, a larger stream called *Bow brook*, rising on the borders of *Dartmoor*, whence it arrives through a succession of vallies, and enters into the same æstuary. In this part of the western side of the gulph, I found very singular effects of the catastrophes of the *strata*. I crossed several small vales, both sides of which consisted of the same species of *strata*, in some *schistose*, in others *calcareous*; while in the intervals between these there were vales which had the *schisti* on one side, and the *lime-stone* on the other. In ascending from *Bow bridge*, I followed first the *Totness* road; but near the top of the hill, I turned off to the west, towards *Bowden*. When I arrived there, Mr. Adams was gone to *Totness*, whence he was not to return till the evening; but I had the pleasure of finding Mrs. ADAMS, whom I had known many years before, and was very happy to see again; and she and her sister Miss DACRES were so kind, after dinner, as to walk with me up to some eminences above *Totness*, from which I had a view of the course of the *Dart* before it enters the gulph.

1025. If,

1025. If, in fine weather, a person were to be transported blindfold to the top of one of these eminences, when his eyes should be uncovered, he could not but be struck with astonishment and admiration by the objects which would present themselves to his view ; it would be impossible to represent them in a single picture, because they change, as in a panorama ; but, considering them as forming different pictures, I know of none but the large landscapes of RUBENS, (which I have always admired on account of the truth of their details,) that could awaken the same idea, or indeed the same sensation. Scenery of this kind cannot be represented by a painter who has any thing of what is called *manner* ; it admits of no affected colouring, no negligence in imitation, nothing arbitrary in the forms ; every object ought to be exactly copied and finished ; for there is always more beauty in these natural features than can be supplied by the imagination of the artist. At a little distance from this place, the hills, as I said in my former journey, approach each other sufficiently from the opposite sides to be connected by a bridge. It is there that the *Dart* enters its gulph, after having flowed through a vast basin, encompassed and intersected by low hills, which ascend towards the eminences of *Dartmoor* ; the latter terminate the prospect on the north, while the *Haldon hills* form its boundary on the east. The beauty, indeed, of this landscape, especially if viewed from the height whence I then looked down upon it, cannot be described ; but to me it was, on another  
account,

account, an object of interest; since my express purpose in coming hither had been to observe the course of the *Dart*, and to compare it with what had been said by Mr. Playfair of the courses of the *Devonshire* rivers, and of this in particular.

1026. This author says first in general, p. 351 of his *Illustrations of the Huttonian theory of the Earth*, (a work which I have constantly in view):  
 “ When we trace up rivers and their branches toward  
 “ their source, we come at last to *rivulets*, that run  
 “ only in time of rain, and that are dry at other  
 “ seasons.” “ It is there,” says Dr. Hutton, “ that  
 “ I would wish to carry my reader, that he may be  
 “ convinced, by his own observation, of this *great*  
 “ *fact, that the rivers have, in general, hollowed*  
 “ *out their valleys.* The changes of the *valley* of  
 “ the *main river* are but *slow*; the plain indeed is  
 “ *wasted* in one place, but is *repaired* in another, and  
 “ we do not perceive the place from whence the re-  
 “ pairing matter has proceeded. That which the  
 “ spectator sees here, does not therefore immediately  
 “ suggest to him what has been the state of things  
 “ *before the valley was hollowed out.* But it is  
 “ otherwise in the *valley* of the *rivulet*; no person  
 “ can examine it without seeing, *that the rivulet*  
 “ *carries away matter which cannot be repaired,*  
 “ *except by wearing away some part of the surface of*  
 “ *the place upon which the rain that forms the*  
 “ *stream is gathered.* The remains of a former state  
 “ are here visible; and we can, without any long  
 “ chain



“ chain of reasoning, compare what has been with  
 “ what is at the present moment. It requires but  
 “ little study to replace the parts removed, and to  
 “ see nature at work, resolving the most hard and  
 “ solid masses, by the continued influences of the  
 “ sun and atmosphere. (*Theory of the Earth*, vol.  
 “ II. p. 294.)” “ We see the beginning of that  
 “ long journey, by which heavy bodies travel *from*  
 “ *the summit of the land to the bottom of the ocean,*  
 “ and we remain convinced, that, on our continents,  
 “ *there is no spot on which a river may not formerly*  
 “ *have run.* (Ibid. p. 296.) The view thus afforded  
 “ of the operations, in their nascent state, which  
 “ have shaped out and fashioned the present surface  
 “ of the land, is necessary to prepare us for following  
 “ them to the utmost extent of their effects. From  
 “ these effects, the truth of the proposition, *that*  
 “ *rivers have cut and formed, not the beds only, but*  
 “ *the whole of the valleys, or rather system of valleys,*  
 “ *through which they flow,* is demonstrated on a  
 “ principle which has a close affinity to that on  
 “ which chances are usually calculated.”

1027. It is difficult for those who have not applied  
 to observations of this nature to refuse their assent  
 to the consequences expressed in the above passage ;  
 because, among the effects here pointed out, there  
 are some which every one may have had opportuni-  
 ties of observing ; and it is probably by these effects  
 that the judgment of Dr. Hutton and Mr. Playfair  
 has been influenced. Here, however, they are given  
 only

only under a general form; but before they can be laid down as principles, they require to be established by precise examples: fortunately Mr. Playfair has undertaken this task, p. 369; and I therefore intend, in the course of these travels, to examine all the instances adduced by him; the following are those which relate to our present object. "If we look at the smaller streams, we find them working their way through the cliffs at the present moment; and we see the *steps* by which the *larger valleys* of the *Dart* and the *Tamer* have been cut down to the level of the sea." I shall have occasion to return to the river *Tamer*, a great part of the course of which I have described in my former journey. With respect to the *Dart*, I have shewn by precise observations in the same journey, (§. 815—§. 822.) that the last eleven miles, from *Totness* to the sea, commonly considered as part of its course, are nothing else than a narrow and winding gulph, between high hills; and that the river, far from having cut this channel, is tending to fill it up, by uniting its own sediments with those of the tides. My present object is the real course of this river, from *Dartmoor* to *Totness*.

1028. The passage above cited by Mr. Playfair from Dr. Hutton contains a kind of specious argument, which has long seduced superficial observers: "The *rivulet* carries away matter which cannot be repaired, except by wearing away some part of the surface of the place upon which the rain that forms the stream is gathered." Many other geologists, since the time of Buffon, have employed this same argument

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under a still more specious form. "The waters," say they, "are continually *carrying down* the materials which they have detached in their descent from mountains; and of these materials none ever *reascend*." The fact is true under both forms; and hence the mind is prepossessed in favour of these systems: but before the conclusions drawn from this fact can be allowed, namely, that the *mountains*, originally much higher than at present, will at last be *reduced to the level of the plains*, and that the channels along which materials have been carried by *streams*, viz. the *vallies*, are the work of those streams, whence must result, that the latter have been flowing on our continents during an incalculable number of ages, many other facts not less evident must be considered, and will be found not only to overturn these conclusions, but to be in direct opposition to the last of them.

1029. Mr. Playfair, following Dr. Hutton, says very little of the *low vallies*; he supposes them to have been *hollowed out* by *ivers*, although he has observed, at least in some places, that their bottom has been *raised* by new materials; but of this object he speaks thus vaguely: "the changes are but slow; ... and we do not perceive the place from whence the *repairing* matter has proceeded." I shall now follow the real *steps* of the *Dart*, in which I shall point out some facts that may be observed in the courses of all *ivers*, when attentively studied. 1. The first *rivulets* formed in mountains, flowed in channels which

which must have existed before the birth of the continents, since they have evidently been produced by anterior catastrophes of the *strata*.—2. Whenever these rivulets, while still in the mountains, came to spaces originally wide and horizontal, they deposited, as is afterwards the case with the largest streams formed by their union, all the materials brought down by them to those points, except the earthy particles, which float in running waters, and are deposited only in low vallies, or on the sea-shore.—3. No stream of whatever size has produced any demolitions in its course, but in places where it has met with such projections, as have opposed its passage; and if these obstacles have made but little resistance, it has attacked, and carried them away.—4. It was in the earliest times that the greatest quantities of materials were transported by running waters; because the channels into which they entered, being obstructed with rubbish produced by anterior catastrophes, they drove this down before them, to spaces wider, and less inclined; and also because the first streams, formed on heights, covered with a loose soil, washed it away in greater abundance, before it was bound by vegetation.—5. Thus, from the highest vallies of the mountains down to the lowest, it evidently appears whence the materials have been brought, with which their bottoms have every where been raised, (rather than deepened,) in all the parts where the declivity was originally but small.—6. Lastly, these changes have been so far from slow, that the increase of the soils thus formed by the deposits of

the waters, is one of the *chronometers* whereby it is demonstrated, that our *continents*, at the birth of which all these operations began, are not of very great antiquity.

1030. The large space encompassed with hills, which precedes the defile of *Totness*, and above which rise the eminences of *Dartmoor*, was the first great receptacle of the materials brought down by the *Dart* and its various branches; and the earthy particles that passed beyond this point were deposited in the long gulph below it, where they have all been retained by the sea-sand brought in by the waves and the tides. The latter new soils I had seen in my former journey; but I had not observed the meadow ground above the defile, into which the tides still ascend a considerable way in the channel preserved there by the *Dart*. I was to pass through this ground in my way to *Ashburton*; but not being acquainted with the road, I consulted Mr. Adams on this subject when he returned; and conversing with him at the same time, of the singular intermixture of the *schistose* hills with those of *lime-stone*, which I had observed on this side of *Torbay*, I asked him whether it continued nearer *Dartmoor*: he told me that it prevailed over a very extensive tract of country; and he advised me not to take the common road from *Totness* to *Ashburton*, but to follow the upper part of the hills on the right bank of the *Dart* as far as *Buckfastleigh*, where I should see an interesting phenomenon of this kind. I accordingly followed this road, and had reason to think

think myself much obliged to Mr. Adams for his directions.

*July 12th.*—I set out from *Bowden* at half past 9 in the morning, and passing by the upper end of *Totness*, which I did not enter, I crossed some hills arranged without order, and exhibiting, by the different inclinations of their *schistose* strata, a scene of the most evident catastrophes. I thus came to the level of the *Dart*, and crossed that river over *Staverton bridge*. Here I entered a large space of horizontal meadows, in which the sides of a canal, lately cut to lead the water towards a mill, exhibited the *history* of the *Dart*, recorded in the same characters as may be seen in the *alluvial lands* of all rivers, when dug through, down to the original ground. The water was very low, so that I saw the section of almost the whole of this soil: at the bottom are large rounded stones, on which lies gravel, successively diminishing in size; but it may be judged that a long time has elapsed since any of this has been brought down, by either the *Dart*, or the smallest of the streams arriving here; for it is covered, to a great thickness, by pure sand, and earthy particles. These are the true *steps* of the *Dart*, and I wish that Mr. Playfair had taken the trouble of observing them.

1031. I crossed the canal by a bridge; and there my driver missed the direct road to *Buckfastleigh*, and took one leading towards the opposite hills, over which we were obliged to pass, though, on arriving at them,

them, we discovered our mistake, because there was no road through the meadows at their foot. However I was not sorry for this incident, as it gave me an opportunity of observing these eminences, where I saw the strata of the *schisti* inclined in different directions in the several hills which succeed each other, and are intersected by *combes*, all tending towards the meadows. From these hills, I descended to *Highbear*, whence I again passed over meadows; and coming to the *Dart*, I recrossed it by a bridge, within a short distance of *Buckfastleigh*. I was now at the foot of the hills on the right bank, along which the river has taken its course; and its water being low, I saw its bed a considerable way above the bridge, composed of the edges of the *strata* of *schisti* dipping inwards; they were uncovered, because the *Dart* being in this part rapid, and its channel narrow, no sediments can remain on the bottom, which is like a pavement; when the water is turbid, during floods, it deposits the greater part of the earthy particles brought down by it in the wide space which it then occupies; and when the stream has retired into its usual channel, it washes down whatever may have settled on its rocky bed. I shall have opportunities, even in the high *vallies* of *Dartmoor*, of describing the same phenomenon, which is very common among mountains, and so evidently shews that *streams* have not excavated their *vallies*; I mean that in their course there are parts where, being rapid, they deposit nothing on their stony beds; all their sediments,

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ever since they began to flow, having been accumulated on horizontal spaces.

1032. The catastrophes of the *strata*, by which have been produced, not only the *vallies*, but the *plains* around eminences, are here shewn in a very striking manner. It has just been seen, that, on the bed of the *Dart*, so near *Dartmoor*, the *strata* of *schistus*, in their subsidence, have undergone an angular motion, by which their upper section has been reduced to this low level; but the catastrophe has been more complex than is indicated by this single circumstance; for a class of the *strata*, which certainly lay originally *over* the *schisti*, having fallen the first into the space where the subsidence happened, and where they almost entirely disappeared, their existence is at present known, only because some parts of them have remained still in sight; and hence some light will be thrown on the exterior intermixture which I have thus far described, of the two kinds of *strata*, *lime-stone* and *schistus*.

1033. After passing over another bridge, a brook falling into the *Dart*, I approached an insulated hill, behind which lay the small town of *Buckfastleigh*. On the hither side of this hill, I saw some quarries at a certain height; and quitting my chaise, I went up to the nearest, where I found worked a *marble* of the same kind which I had seen in *Chudleigh rock*, (§ 790.) and had also observed here and there between *Torbay* and *Totness*. The *strata* were so much broken



broken and disordered, that I could not, in this spot, discover their situation; but I saw it afterwards in another part of the hill. In descending from this quarry by a different path, I had an opportunity of perceiving the connexion between these *calcareous strata*, and those of *schistus* and *grey wacke*, of which the former is called *slate* in this part of the country, and the latter *Dunstone*, as I have already said. As I came down this path, I found, under the section of the *calcareous strata*, that of both these other kinds; and continuing to follow the hill around its northern extremity, where appeared a lateral section of all the strata, in part covered with grass, because no quarries are yet opened on it, I saw them descending westward, on the side next the vale of *Buckfastleigh*: the *strata* of *slate* and *dunstone* first disappear under the loose soil round the base of the hill, and afterwards the *calcareous strata*, which are here more regular,

1034. I proceeded this way to *Buckfastleigh*; I passed through that place; and continuing my walk round the hill, when I came to the same part of it which I had first observed, I met a gentleman of the town, whom I accosted, in order to make some inquiries of him; and I found him well disposed to give me such information as I desired. My first question related to this remarkable situation of *strata* of different natures; and on my asking him whether they were found in the same order in other parts of the country, he told me that, wherever the same kinds were discovered

covered together, the strata of *lime-stone* were always above those of *slate* and *gunstone*. I then mentioned, as an extraordinary circumstance, that hills composed of *lime-stone* should be found among others consisting of *slate* and *gunstone*; whereupon he told me, of his own accord, that, in this country, every thing indicated that there had been great revolutions, which had produced, not merely this external disorder, but also great effects in the internal parts of the ground. He then informed me that, in the mass of the *calcareous strata*, there were large *caverns*, divided into different chambers, adorned with pillars of stalactites; that it was dangerous to proceed far in these *caverns*, on account of fissures so deep, that, if a large stone was thrown down them, it was heard for some time to strike against the sides, after which the noise generally died away; but in those chasms where the stone could be heard to reach the bottom, the sound was that of falling into water: that these *caverns* communicated with each other by passages more or less wide, forming a kind of subterranean labyrinth, in which nobody durst venture far, and of which, therefore, the extent remained unknown. As an instance of this, he told me that, some time before, when he had been out shooting, one of his dogs, pursuing a rabbit, had entered a hole in a rock; that he had waited for him and called him a long time, but in vain, so that he had concluded him actually lost in some cavern; however, after some days, the dog returned home, but excessively lean, and almost dying; so that, though  
 much

much care was taken of him, it was a great while before he recovered.

1035. From the several facts here adduced, no doubt can remain that all the *strata* have undergone a *subsidence*, attended with *angular motions* of their masses divided by fractures; and that the low space, through which the *Dart* now winds, is the part where this *subsidence* was the greatest. The small hills encompassing this space shew, by their irregular forms, and the inclination of their *strata* in every direction, that they are masses remaining more elevated around it; and we have seen that the *Dart* flows at their foot, over the edges of the sunken *strata*, of which the greatest part is now concealed by the sediments of the river, and of all the torrents arriving in this space, deposited during floods. The *calcareous strata* have here disappeared, as is the case in many places, where they are missing on the surface, though they must have been produced uniformly on the *schisti*; being thus the uppermost in the masses divided by the fractures, they slipped the foremost towards the point of the greatest *subsidence*, where they are now covered by the masses which fell over them; all the exterior *strata* surrounding this low space being seen inclined towards it. Farther, it is only by *subsidence* that *caverns* can have been produced in these masses, as I have already shewn by the description of those of the *Mendip hills*. It is principally in the *strata* of *lime-stone* that this phenomenon is observed, because they are thicker and harder

harder than those of the *schist*: when fractures did not pass directly through all the *strata*, the upper parts of some of the separated masses, being supported on the sides, could not follow the under parts down to the uneven bottom of the internal *caverns*, to the formation of which, by the cause explained in the *Elementary Treatise*, I have ascribed the catastrophes many times repeated in the same places. In the above account of the caverns at *Buckfastleigh* has been seen an example of deep fractures, which, when they have not passed across all the *strata*, have occasioned the unequal subsidences of the different parts of the masses thus separated. I do not believe it possible, that those who have attentively considered, in different countries, the variety of the dislocations which have taken place in the masses of strata divided by catastrophes, can retain the idea that the forms of the surface of the continents, and in particular *vallies* comparatively with *eminences*, have been produced by the erosion of the waters; especially when to this consideration are added all the facts which directly prove, that these waters, at every height along their whole course, instead of forming *cavities*, have filled up those which before existed.

1036. After these observations at *Buckfastleigh*, I returned to my chaise, and having continued for a little way to ascend the course of the *Dart*, I crossed over, by a bridge, to its left bank. Here again I saw, through the limpid water, that the bed of the river, along a great space, at the foot of the hills, is formed  
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of the edges of the *strata* of *schistus* dipping inwards. This is still the lowest part of the course of the *Dart*, and the same phenomenon will again be seen in the vallies of *Dartmoor*; whence it will appear, that the *strata* suffered these catastrophes in the whole of their mass, with more or less *subsidence* and *angular motion* of their separated parts.

1037. I proceeded towards *Ashburton*, where I arrived at three o'clock, and experienced the most friendly reception from Mr. Kitson and his amiable wife. I had arranged my plan so as to arrive at this place on a saturday, because Mr. Kitson had informed me that he went every sunday to perform divine service at *Buckland*, which is situated on *Dartmoor*, but annexed to the parish of *Ashburton*; and he had offered to take me with him, in order that, in going thither, and returning by different roads, I might form a first idea of that chain of eminences. The next morning we accordingly set out as he had proposed. This was a very interesting excursion; but that I may be as little as possible obliged to interrupt my account of it by deducing conclusions from the phenomena which I observed, I shall previously make two leading remarks.

1038. First, we shall here return to the subject of the *blocks* of *granite* scattered over soils of a nature different from their own. I have already had occasion to say, that those geologists who have considered, either from a superficial observation, or only  
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on the reports of others, this great phenomenon of the *blocks* disseminated in so many parts of the surface of the continents, have contented themselves with a vague idea, that, in the course of thousands of ages, these *blocks*, having been detached from eminences of their own kind, *may have migrated*, either by the impulse of running waters, or by a gradual descent down the slopes; and this is, in particular, the idea of Mr. Playfair. But *blocks* found on the highest eminences of a very extensive tract of country, which is the case with these on *Dartmoor*, cannot have *migrated* in any manner; and if Mr. Playfair had observed them, he would have been obliged to acknowledge here, as well as with respect to the *flints* on the *Blackdown hills*, (p. 374,) that "there is no *higher* ground in the "neighbourhood from which" these masses "can "be supposed to have come, nor any stream that "can have carried" them. Recourse, then, must be had to some other cause; and by the details of this phenomenon on *Dartmoor* it will be seen, that there cannot be any other than that which I have assigned to all phenomena of the same class; namely, the catastrophes of the *strata*, during which the internal fluids, violently compressed by the *subsidence* of the separated masses, cast out these fragments detached by the collision of those masses in their angular motions.

1039. Secondly, we shall likewise be led back to the cause of *vallies*, by those in the chain of *Dartmoor*, where we shall find them one of the principal objects.

objects. If they had been excavated by *running waters*, the latter could not have acted in any other manner than as Mr. Playfair himself supposes ; (p. 105 ;) that is to say, “ in the same way, and almost with the same *instrument*, by which the “ lapidary divides a block of marble or of granite.” Therefore, as a *saw* cannot cut out of the strait line of its course, or without a rapid motion, so neither can *streams* have widened certain parts of the vallies ; since we see their action cease, when, after having flowed rapidly in narrow passages they issue forth into wide spaces. Nor could great inequalities be found on their beds, such as spaces nearly *horizontal*, succeeded by abrupt *descents* of different lengths ; for like the *saw*, they could not cut their bottom except in a strait line, or with slight inflexions occasioned by the different degrees of hardness in the rock. It is not so evidently unnatural to suppose with Mr. Playfair, (p. 361,) that *running waters* have tended to obliterate existing *cataracts*, by lowering the channels whence they fall ; though, in fact, many cataracts which I have observed, and of which I shall mention some hereafter, plainly show that this is not the case ; but it is impossible to conceive that any currents can have produced *cataracts*, or even small  *Cascades*, by cutting *vertically* a rock, on which they originally only glided. Thus the great *widenings* in some parts of the *vallies*, together with the  *Cascades* and other  *falls* succeeding spaces nearly *horizontal*, must necessarily have existed antecedently to the flowing of  *streams*, and must be original forms of the *vallies*. Such are the two principal

pal points which will be established by the following observations in *Dartmoor*.

*July 13th.* We set out from *Ashburton* at nine in the morning, Mr. Kitson taking me with him in his one-horse chaise. After proceeding a little way, we began to ascend a ridge of hills, separating the *combe* in the lower part of which the town is built, from the *valley* wherein flows the *Dart*. On reaching the top of the first hill, we had a view of that river in its valley; but as we advanced, the ridge became higher; and having the *Dart*, constantly in sight on the left of our road, we could perceive how much we rose above its level. The first object which fixed my attention was a very *wide space* in this *valley*, known by the name of the *Park*, surrounded with a fine amphitheatre of eminences clothed with verdure. The *Dart* winds through this space, the bottom of which is interspersed with hillocks, their intervals being occupied by corn-fields; and in the parts still overflowed by the river, there are meadows on its borders. In our return, we went down into this basin, which is within the bounds of *Dartmoor*, on purpose to observe it; and I shall then describe it more particularly.

1040. We ascended nearly to the general level of this part of *Dartmoor*, on which rise several insulated hills. It may easily be judged that running waters have not excavated the intervals between these hills, at a height where the surface can receive no  
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water but that of the immediate drops of rain ; but the very nature of the eminences themselves will show them to have been produced by the catastrophes of the strata. Two of these eminences happened to lie in our way ; they are nearly of the same height, and, when seen from a distance, they appear of the same nature ; their grassy slopes are equally covered with large blocks, and on the summits of both rise those insulated rocks which are known by the name of *Tors*. As we passed along the foot of the first of these eminences, called *Hazelwell*, we saw that its *blocks*, as well as the *rocks* on its summit, consisted of *dunstone* ; and at the same time we discovered in its lower part a section of *strata* of the same kind. From this circumstance, superficial observers might suppose, that some exterior cause had detached the *blocks* from the hill, and lowered its surface around the *rocks* on its summit. I shall not here stop to mention some particulars which prove that these effects have not been produced by any operation on the surface, because the following eminence will render it fully evident that such a supposition would be groundless.

1041. These two hills are separated by a vale, covered with grass, and rising towards both in a gentle slope ; (a form which alone might prove this interval not to have been produced by the erosion of a current ;) and having passed the lower part of this vale in our way to *Buckland*, we proceeded along the foot of the second eminence, called *Buckland beacon*.

*beacon*. Here, in a part which had been cut away to make the road, we found the mass of this hill, like that of *Hazelwell*, to consist of *dunstone*; and it will be seen in the sequel, that the *strata* of this stone, intermixed with those of *schistus*, compose the whole mass of this part of *Dartmoor*, down to the level of the *Dart*. Yet here the *blocks* and the *tors* are of *granite*, while those of *Hazelwell*, at so small a distance, are, as I have said, of *dunstone*.

1042. I could wish, that Mr. Playfair had observed these phenomena, in a country which is known to him, before he had recurred to so many different hypotheses to account for the superficial masses of *granite* observed in countries with which he is absolutely unacquainted. It is in his XVIIIth *Illustrative Note* that he principally treats of this subject. I have examined, in my *Elementary Treatise*, his hypothesis with regard to the *blocks* of *granite* scattered on the *Jura*, which he supposes to have been brought down by running waters from the summit of the *Alps*, before the intermediate *vallies* had been *excavated*; and in the 1st Vol. of these *Travels*, I have likewise examined his supposition that the vast quantities of *blocks* of *granite* disseminated on the shores of the *Baltic* came from the *Carpathian mountains*. But there being at the *Cape of Good Hope* a great phenomenon of this kind, to which none of his former explanations can

be applied, he has, p. 399, introduced a new one, founded on the part of the Huttonian system that supposes *granite* to have been a substance *in fusion*, which was heaved up under the *strata*, and thus penetrated their fissures. "The most remarkable examples of this sort," he says, "are the stones found at the *Cape of Good Hope*, on the hill called *Puarlberg*, which takes its name from a chain of large round stones, like the pearls of a necklace, that passes over the summit. Two of these, placed near the highest point, are called the *Pearl* and the *Diamond*. . . . From a recent account, these stones appear to be a species of *granite*, though the hill on which they lie is composed of *sandstone strata*. The *Pearl* is a naked rock, that rises to the height of 400 feet above the summit of the hill; the *Diamond* is higher, but its base is less, and it is more inaccessible. From the above stones forming a regular chain, as well as from the immense size of the two largest, it is impossible to suppose that they have been moved; and it is *infinitely more probable*, that they are parts of a *granite vein*, which runs across the *sand-stone strata*, and of which some parts have resisted the action of the weather, while the rest have yielded to it. . . . . Loose *blocks* of *granite* are seen in great abundance at the *foot of the Table mountain*, and *along the sea-shore*."

1043. This latter circumstance ought alone to have prevented Mr. Playfair's hypothesis, that the stones on *Paarlberg* are the remains of a vein of *granite*, injected into a fissure of *sand-stone strata*; such being the system, as an example of which he adduces this phenomenon. Now should we suppose, with him, that a *vein of granite* had been formed here, and that afterwards, by the action of atmospheric causes, the *strata* of *sand-stone* had been destroyed at its foot to the depth of 400 feet, the harder mass being thus left uncovered; where should we expect to find the *blocks* detached from it? Most certainly around its foot; since this being the highest part of the country, no stream could have been formed, even to move them, much less to carry them round the *Table mountain*, and down to the *coast*. This circumstance, I say, as related by Mr. Playfair himself, is sufficient to render his explanation *absolutely improbable*.

1044. But why has he sought for examples at the *Cape of Good Hope*, while it is so little possible for those who have not been there to ascertain the circumstances that accompany the phenomenon of *Paarlberg*? Why, especially, when he has travelled in *Devonshire* and *Cornwall*, counties which contain as great phenomena of this kind, and with much more variety, where also the descriptions given of them may easily be verified, has he not there studied these phenomena, and attempted to apply to them his hypotheses? He has done this, indeed, with

regard to some places in *Cornwall*, and when I shall come to them, I will cite what he has said; but before that time, it will be seen from my descriptions of circumstances belonging to this class of phenomena, that they are inexplicable, either by any cause acting externally, or by his idea of an injection of *granite* into the fissures of the other *strata*; and that they cannot really be ascribed to any other cause than that which I have mentioned above, namely, the catastrophes of the *strata*, attended with explosions of the *interior fluids*, violently compressed by the *subsidence* of the divided masses; whence it results that, at the time when our *continents* were left dry by the retreat of the sea, all these *blocks* were already scattered over their surface, in the places where we at present find them.

1045. After the service of the Church was over, Mr. Kitson took me to *Buckland House*, a seat belonging to Mr. BASTARD. There I had the pleasure of finding Captain Martin, whom I mentioned in my former journey, as having so much assisted me in my observations at *Plymouth*: Mr. Bastard having lent him the house, he was come, with his family, to spend the summer there; and being already acquainted with the adjacent country, he was so good as to go down with us into the valley in which the *Dart* flows. As there was only a foot-path this way, Mr. Kitson sent his chaise to wait for us at the place where we were to return into the *Ashburton* road.

1046. Immediately below *Buckland*, we began to descend through a coppice, which covers a very rapid slope: the path has been made, for the most part, by clearing away the rubbish that forms the slope: but here and there it has been necessary to cut through some projecting rocks, and in these appear dunstone and schistus, the strata of which descend obliquely into the interior part of the mountain. As we went down, we had, from one point, a view up a very deep *valley*, terminated abruptly by a beautiful *cascade* formed by the small river *Westbourn*, which rises in a large *combe* above called *Widecomb*. Mr. Kitson told me that, during the melting of the snows on *Dartmoor*, the noise of this water-fall was heard at the distance of two miles all around. Now after this long vertical fall, the *Westbourn*, being arrived in the low *valley*, flows calmly along great spaces nearly horizontal, which being successively lower than each other, small cascades of the river are thus produced between them. No effort of imagination can represent this little river as cutting its channel in the manner of a *saw*; and, at the same time, this channel evidently appears to have been the effect of the catastrophes of the *strata*, by the state in which they are seen on the sides of the *valley*.

1047. At the bottom of this long descent, we came to the borders of the *Westbourn*, which we followed to a point where its valley, by a turn, opens into that of the *Dart*; a spot very interesting on many accounts. The *Dart* arrives here through  
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a very deep *valley*, containing several *wide spaces*; its current is impeded by bars, formed of the higher parts of sunken *strata* descending inwards; these bars produce in the course of the river small pools, which are succeeded either by falls, or by a more rapid current over the edges of the strata, among stones and even blocks of granite. The two rivers meet at a point where they both flow very rapidly; but a little below their junction, they resume a tranquil course through a long space, nearly horizontal. Evident proofs appear in this spot, first, that the *Dart* has not excavated its valley, and secondly, that it has no action on its bed: for in the first case, it would have worn away all the *bars* which occasion the small *pools*; and, with respect to the second, a proof that the river produces no erosion is afforded by the aquatic plants, with which, through its limpid water, in the space just mentioned, I saw its bottom covered.

1048. In all the parts where the original breadth of the vallies has given these rivers room to spread, they have deposited a *sand* brought down from the heights, in rainy seasons, by their first branches: this took place very abundantly in early times; that is to say, before the grounds were covered by vegetation; but since then it has successively diminished. I have said, in my former journey, that this *sand*, which is found on *Dartmoor* in such vast quantities, resembles decomposed granite; but I have deferred examining this point, till I shall come to my observations

vations in *Cornwall*; and I mention it here, only because the alluvial ground formed by the *Dart* and its branches in the vallies of *Dartmoor* consists of this sand. The *Westbourn* has deposited a prodigious abundance of it in the wide parts of the valley below the cascade, and especially along the foot of the slope that we had descended from *Buckland*; here a wood has sprung up, which at present, as Mr. Kitson informed me, is but seldom overflowed by the river; and as grass has not grown under the shadow of the trees, the sand remains loose, and is fetched from this place for various purposes: but no such abundance of sand has been brought down since the eminences have been overspread by vegetation; and Mr. Kitson told me, that the brooks which descend from *Dartmoor* seldom become turbid from rain, unless it is of long duration; and even then, when it ceases, before all its water has run off, these streams are again limpid.

1049. In the part where the two vallies join, we observed a phenomenon characteristic of the catastrophe, by which they were produced, before any streams were formed to flow in them. The blocks on the bed of both the rivers; above and below this place, are of a greyish granite, like those scattered on the eminences and on their slopes; but at this point we found some of a fine granite with red feldspar; and we even observed different species of these, there being differences in the size of the crystals, both of the quartz and of the feldspar. We saw  
also



also a large mass which a lapidary would have been very glad to possess ; this was of pure quartz, with stripes of various shades of green, resembling ribbons. I have seen masses of the same stone, and also among blocks of *granite* with red feldspar, on the sandy hills in the country of *Bremen*. Mr. Kitson, who is well acquainted with *Dartmoor*, told me that, on the eminences, he had never seen stones of either of these two kinds. This is one of the phenomena, so numerous, and belonging to so many classes of stones, which demonstrate that the *blocks* scattered over the continents have not *migrated* on their surface ; but, having been cast out from within, have brought to our view specimens of some of the inferior *strata*, which otherwise we should never have known to exist in those parts of the continents.

1050. I wished to see the space called the *Park*, of which I spoke above ; and Mr. Kitson had the kindness to conduct me thither, after we had taken leave of Captain Martin, who returned to *Buckland*. We crossed the *Westbourn* by a bridge, and for some way proceeded up the left bank of the *Dart*, till, having traversed a large space surrounded with eminences, in a part where the river makes a wide bend, we came to a bridge called *New bridge on Dart*. Within this space, there are great alluvial soils, formed of the coarse *sand* above mentioned, and interspersed with small hills, which extend into *Spitchwick Park*, belonging to Lord ASHBURTON, and which,

which, from the height whence we had viewed this space in the morning, had appeared to be only inflexions of the surface. The *Dart*, in this part of its course, still within *Dartmoor*, is evidently seen to have had no share whatever in the *formation* of the valley in which it flows; for, in the first place, how could it have produced this *wide space*, contracted at both extremities? And with respect to the surface of this space, how could the river, which occupies it during floods, have dissected it into small hills, while, on the contrary, the soil between them has been raised by the sediments of the stream.

1051. Returning from *New bridge* to the point where the *Dart* is joined by the *Westbourn*, we thence proceeded down the left bank of the former. After going some way, we passed a brook, which, rising on the hill, and flowing down a sinuosity of the slope, falls also into the *Dart*. On seeing this brook rush precipitously and foam amidst *blocks* of *granite*, it might easily be supposed to have brought them down from the heights, and still to carry them along with it when swelled by rains; but the illusion is dissipated, when we see *blocks* appearing through the grass and bushes on the whole of the slope; for this shews that the only real operation of the brook has been to wash away the sand with which the intervals between the *blocks* were originally filled: more striking instances of the same operation will hereafter be seen in other parts of *Dartmoor*. Thus the first rains falling on these  
eminences

eminences brought down not only the sand from their surface, as yet not bound by the roots of plants, but that which had occupied the intervals of the *blocks*, in the sinuosities of the slopes, where the first rivulets were formed; and the soil of the vallies was hereby considerably raised; but this effect has been ever since diminishing, as will appear in the sequel.

1052. A work undertaken on this slope, covered with sand and blocks of granite, has shewn of what materials the mass of these mountains consists; as in the case already described on the slope below *Buckland*. The former slope belongs to the lower part of the eminence called *Hazelwell*, of which I have spoken before, and at a small height above the valley had been worked for some time a mine called *Hazel mine*; indications of a vein of copper having been discovered in a section of the strata, and followed some way in the hill, Mr. Bastard, being lord of the manor, had caused a road to be made on the slope, in order to facilitate the access to this mine. Now after having cleared away the blocks and the sand along the line marked out for this road, it had been cut in the *dunstone*, and afterwards in strata of *gneiss*; in which the above indications of a vein had been found; and on this subject I must here make a few general remarks.

1053. I shewed in my first geological work, what M. WERNER has since proved by demonstrative characters, that veins are fissures, produced in the strata by their first catastrophes, and filled with new materials

materials called *gangue*. The most profitable *veins* are those which have been formed in the principal *fissures*, the *gangue* contained in them being of such a thickness, that no unnecessary expense is incurred by cutting away more or less on the sides, in order to open the road into the hill. These *fissures*, however, are commonly accompanied by others, contemporary in their production, but sometimes very small, which branch off from the former, and are filled with the same *gangue*. It is for this reason, that when, in the sections of *strata* appearing on the summits or the slopes of mountains, any of these branches are perceived, there is hope that, in following them, the principal *vein* may be found; which, indeed, sometimes happens, and proves an encouragement to similar undertakings, as the large prizes gained in lotteries by some induce others to purchase tickets. A first and absolute cause of ill success is, that in the later catastrophes of the *strata*, the principal *vein* has, in some places, happened to be in the mass of which the subsidence has formed a *valley*; the sides of the *valley* retaining only the branches of the *vein*. Another cause of the failure of these enterprizes is, that, as the mine is carried farther into the hill, the expense increases; for the mine must be drained from the waters which enter it, and the materials detached must be brought out from a greater distance; and this, merely in the hope of arriving at the principal *vein*, for these small branches yield very little ore; so that at last the undertaking is given up, sometimes at the very moment when success is at hand. There was

was an instance of this kind in the *Pyrenees*, at the beginning of the last century: the principal adventurer, with whom I was afterwards acquainted, had spent the whole of a large fortune in following, for many years, these indications of a *vein*; when, not chusing to involve himself in debts, he assembled his miners, told them his situation, and declared to them that he gave up the enterprize: but the miners, who had always been well treated by him, and had gained much in his service, declared to him unanimously that they would not abandon the pursuit till they should have spent the whole of their gains; and he, being moved by their behaviour, promised them a certain share of the profit, if they at last succeeded. The work was therefore continued, and they came to the *vein*, which proved so rich, that they were all abundantly recompensed for their perseverance. This, however, has not been the case at *Hazel mine*: the *small veins* of *copper pyrites* which were followed there had, from the beginning, paid but a very small part of the expense; and the latter becoming more and more considerable, while there was no increase in the product, the work, as I have since heard, has at last been given up.

1054. Continuing from hence to follow the *Dart*, we crossed it, and entered another wide space in its *valley*, encompassed with eminences; this also we had seen in the morning, in passing over the heights, whence it had appeared as if covered with meadows, which we now found to be fields of corn still green.

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The soil here cultivated is composed of the coarse *sand* described above, deposited by the *Dart* in this horizontal space, where the river lost all rapidity in its inundations : now it is known by tradition that, not more than a century ago, this space was still sometimes overflowed ; but that, its soil having thus been raised, it became at last so little liable to floods, that it has now been cultivated for a long time, almost without any apprehension of them. The river has preserved its course along the foot of the hills, which on one side border this space, where it commonly flows much below the surface, because of the thickness of the alluvial soil ; this was the case when we were there ; and on its side next the hills I saw the strata of *dunstone*, while the other consisted of the coarse *sand*. Here then, within *Dartmoor*, where Mr. Playfair supposes that we may trace the *steps* of the *Dart* in the *excavation* of *vallies*, we find an example of the contrary operation, that of *filling* them up ; the sensible *progress* of which proves this river not to have flowed during any very great number of ages.

1055. We here quitted the *Dart*, having recrossed it by a bridge, and passed over the hill separating its valley from the large combe, at the lower extremity of which *Ashburton* is situated. This town, like that of *Totness*, rises up two opposite slopes ; the rivulet issuing from the combe is so small, that in the lower part of the town, which it crosses, it is not seen, being carried under the street and the houses

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on both its sides, through a canal. The foregoing description of the course of the *Dart*, from *Dartmoor* to *Totness*, where it arrives at the level of the sea, together with that given in the preceding journey of the *gulph* which it there enters, will, I hope, contribute to change Mr. Playfair's opinion with respect to what he has considered as proved by this river.

*July 14th.* It was on this day that I had a rendezvous, at eleven in the morning, with Mr. Short and Mr. Hill, near the spot where the *Bovey coal* is found; whither Mr. Kitson had the farther kindness to accompany me. Our respective distances had been so exactly calculated, that we were all met within a quarter of an hour; but at that very moment a heavy rain came on, which deprived me of the advantage of observing this place a second time, in the company of persons so well informed of every particular relating to it. However, I went hastily round the excavation, but saw there only the same phenomena as I had observed the year before, the lower *strata* being still under water. The weather then obliging us to separate, and Mr. Short having been so good as to recommend me to Mr. Hill, I accompanied the latter gentleman to *Hennock*.

1056. Having passed through the small town of *Bovey Tracey*, we ascended one of the eastern branches of *Dartmoor* by a very steep road; and the rain ceasing when we reached *Hennock*, Mr. Hill

Hill, after having presented me as his guest to Mrs. HILL, proposed to me that we should walk up to an eminence called *Botter rock*, which is one of the *tors* of this part of *Dartmoor*. This is a spot very proper for observation; for, to the south, it commands a view of the extensive plain, interspersed with small eminences, which occupies a great part of the hundred of *Teignbridge*, and is crossed by a multitude of small streams, proceeding from *Dartmoor* on the west, and the *Haldon hills* on the east, and uniting to form the river *Teign*, the course of which to the sea I described in my last journey.

1057. I have said that Mr. Short had particularly recommended me to Mr. Hill, on account of his knowledge of mineralogy, and especially of every thing relating to *Dartmoor*; circumstances from which I derived great advantage. Moreover, Mr. Hill was acquainted with Mr. Playfair's work, and perfectly agreed with me in considering it as a mistake to ascribe *vallies* to the action of *running waters*: this, therefore, was one of the objects to which he directed my attention in our excursions; and he pointed out to me several examples of the fact so frequently occurring, viz. that the forms of *vallies*, and the differences of their sides, are absolutely contrary to such an opinion.

1058. The slope by which we went up to *Botter rock* is covered with a great quantity of *blocks* and other fragments of a blackish stone, considered as  
*basaltic*



*basaltic* by the naturalists of the country, though it shews no appearance of a prismatic form; yet it certainly has one of the characters of *basalt*, its surface, when exposed to the air, becoming, like that of the latter, of a yellowish grey; a change which takes place in the smallest fragments, and is produced in a very short time; so that the blackish colour of the stone appears only in the parts recently broken. The rain came on again while we were on *Botter rock*, and put an end for this day to our observations, obliging us to return to *Hennock*.

*July 15th.* Mr. Hill was so good as to accompany me again to the top of these eminences, in order to shew me the differences between rocks, at no great distance from each other, and rising to an equal height above the common level; a proof of very great catastrophes in the masses of *strata* forming the hills on the sides of *vallies*. We went first under *Botter rock*, which consists of a blackish stone, resembling that of the masses covering the slope below it on the *Hennock* side; so that, at first sight, these masses might be supposed to have fallen from the rock; but, on examination, it may be presently discovered that this is not the case; for the stone of the rock is full of white spots, which give it the appearance of a kind of porphyry, and seem to be crystals of feldspar; while there are none of these spots in the masses scattered on the slope. Beyond this, at but little distance, and on the same level, we came to rocks of *granite*; so that the *strata* of *Botter rock* might

might appear to be a transition from *granite* to that stone without crystals which, though its strata do not appear, is scattered in masses over the slope. What sort of connexion there is between these three kinds of stone on the same level cannot be perceived, because their intervals are covered with a great thickness of loose soil; and it plainly appears that this soil is not the *detritus* of any of the *strata*, for it consists of a reddish sand, which was then planted with potatoes. We have already seen on the *Mendip hills*, and on a hill near *Torbay*, and we shall again see on other hills, the ruins of *stony strata*, covered with *sands* which cannot have been brought there by any cause since the continent has existed: and this phenomenon will throw some light on the coarse *sand* consisting of the component parts of *granite*, scattered over *Dartmoor* and over the eminences of *Cornwall*.

1059. Proceeding on our way, we came to a large *tor* of *granite*, which is called *Shapter down*, because its summit is covered with turf, the grass growing on the vegetable earth produced by its own annual deposits. When I was at the foot of this rock, I was struck with its extent, and with the height to which it rises above the summit of the hill. I have seen some like it on the summits of the *Hartz* and of the *Giants' mountains*; but there *granite* is found even in the vallies; while the *strata* of *Dartmoor*, wherever they can be discovered on its slopes, are seen to be of *grey wacke*, *gneiss*, and *schistus*. Around this rock

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of *granite*, the loose soil, which, as I have said, conceals the connexion between the different kinds of *strata*, is mixed with fragments of stones of various species, some masses of these being also scattered there.

1060. As we advanced westward on this eminence, Mr. Hill shewed me one of the phenomena which he had wished to point out, as very contrary to the system that *running waters* have hollowed out vallies. We looked down on a large valley, whence, near *Bovey Tracey*, the river *Bovey* issues; yet I perceived only a very small stream flowing in it: this, however, as Mr. Hill told me, is not the *Bovey*; it is a mere brook called the *Wrey*, arriving from the northern part of *Dartmoor*. The other side of this valley, which was opposite to us, consists of a great slope coming down from the eminences of *Dartmoor*, and appearing to be intersected with but slight inflexions, which obliquely descend towards the lower part. Mr. Hill told me that these lines indicated small *vales*, formed one above another on that side of the large valley; and he pointed out to me one of them as the channel of the *Bovey*, which rises in higher grounds. Thus there remains no possibility of explaining the principal valley, otherwise than by fractures, accompanied by the subsidence of a large intermediate mass. This will be further seen in another excursion, when I observed immediately this slope, which we now viewed from a distance.

1061. The

1061. The rain again overtook us on these heights, and obliged us to return to *Hennock*; in our way back, however, passing again by *Botter rock*, Mr. Hill led me to a part of the foot of that *tor*, where there are hollows like small caverns; and in these he shewed me a vegetable phenomenon, which I had never seen but in the granitic mountains separating the country of *Bayreuth* from *Bohemia*. The innermost part of these cavities is lined with a very pretty moss, which reflects the light in the same manner as the eyes of a cat. So little light reaches these remote recesses, that, on looking in from without, they appear quite dark; but, when viewed from a particular point, the part of the rock which is covered with this moss is suddenly seen to shine with a fine emerald green.

1062. On our return to *Hennock*, we continued to converse together on the subjects of our observations, and particularly concerning the blocks of *granite* dispersed over *Dartmoor*, which form an object of great importance in the theory of the earth, and especially in the history of our continents; because this phenomenon is necessarily connected with the questions relating to the origin of *vallies*, and the actions of *running waters*. We spoke also of that coarse *sand* resembling decomposed *granite*; a phenomenon which is common to many granitic mountains, and which I had seen with surprize, in the *Alps*, as well as in many mountains in *Germany*, both in the *vallies* and on the eminences, without

~~was~~ ~~not~~ able to account for it in any manner  
~~necessary~~ to myself. Mr. Hill had likewise fixed  
~~his attention~~ on this phenomenon, especially because  
~~the same~~ is found, not only scattered on the  
~~mountains~~, but in regular indurated *strata*, which in  
~~Cornwall~~ are called *growan*, and are traversed by  
~~metallic~~ veins. As this latter phenomenon  
~~begins~~ to appear in the part of *Dartmoor* over which  
 I was to pass the next day in my road into *Cornwall*,  
 Mr. Hill was so good as to offer to accompany me so  
 far on the way, and I very thankfully accepted the  
 proposal.

1063. We shall continue for some time in a coun-  
 try in which *granite* will be a principal object of  
 attention; especially on account of the part of the  
 Huttonian theory where it is considered as a sub-  
 stance raised up under the *strata* in a state of *fusion*.  
 I have shewn in the *Elementary Treatise*, that most  
 probably Dr. Hutton imagined this hypothesis,  
 merely with a view of tacitly replying to one of the  
 objections, which, in my Letters, I had opposed to  
 his theory of the *elevation* of our continents, as ex-  
 pressed in his first publication. My objection had  
 been, that, as this *elevation* could have been effected  
 no otherwise than by expansible fluids violently con-  
 densed, these fluids necessarily escaping by the innu-  
 merable fractures observed in the *strata*, the elevated  
 mass would have fallen down again, and thus no  
 continents would have been produced. Without  
 mentioning this objection, (which Mr. Playfair has  
 since

since passed over in the same manner,) Dr. Hutton introduced into his second publication the hypothesis of the *granite in fusion*, raised up under the *strata*; and on this he seems to have depended for filling up the fractures, and thus closing the passage to the expansible fluids.

1064. But a direct objection had been urged against this idea, by the author of a work entitled *Minerology of the Scottish Isles*. *Granite*, (or the quartzeous substances associated with it, such as *gneiss*,) is seen even in the highest eminences of the continents; for example, in *Mont Blanc*, the most lofty summit of the *Alps*: if then it had been raised to their summits through the *strata*, in a state of *fusion*, why should it not have flowed out, like the *lavas of Etna* and of the *Andes*? In replying to this author, Mr. Playfair treats his objection as unjust, because, as he asserts, it separates parts of the theory which were intended mutually to support each other: and he thus explains it according to Dr. Hutton, p. 340. “ The truth is, that his theory, at  
 “ the same time that it conceives this stone to have  
 “ been in *fusion*, supposes it to have been, in that  
 “ state, injected among the *strata* already consoli-  
 “ dated; to have heaved them up, and to have been  
 “ formed in the concavity so produced, as in a  
 “ mould. Thus *Mont Blanc*, supposing that it is  
 “ *unstratified*, is understood to consist of a mass  
 “ that was *melted* by subterraneous heat under the  
 “ *strata*, and being impelled upwards by a force,  
 “ that

“ that may stand in some comparison with that  
 “ which projected the planets in their orbits, heaved  
 “ up the *strata* by which it was covered, and in  
 “ which it remained included on all sides. The  
 “ covering of *strata*, thus raised up, may have been  
 “ burst asunder at the summit, where the curvature  
 “ and elevation were the greatest; but the *melted*  
 “ mass underneath may have already acquired  
 “ *solidity*, or may have been sustained by the beds  
 “ of *schistus* incumbent on its sides. This *schistus*,  
 “ forming the exterior crust, was immediately acted  
 “ on by the causes of waste and decomposition,  
 “ which have long since stripped the granite of a  
 “ great part of its covering, and are now exercising  
 “ their power on the central mass.”

1065. I have already shewn in the *Elementary Treatise*, from most clear and particular descriptions by M. de Saussure, (the exactness of which I know from my own observations,) that this explanation is completely upset by facts; for the mass of *Mont Blanc*, and of the *Aiguilles* surrounding it, is as visibly *stratified* as any other mineral substance, and the *strata* of these eminences have been *inclined*, like those of the *schisti* around them, by the catastrophes which they have in common undergone. Most of my readers are, however, like Mr. Playfair, unacquainted with the *Alps*; and arguments deduced from facts little known will always leave in the mind some uncertainty with respect to their objects; but Mr. Playfair is acquainted with *Devonshire* and

*Cornwall*, these being counties through which he has travelled, and they probably are likewise known to many of my readers; here, therefore, I shall compare the different parts of the above passage with precise facts, the general nature of which I shall now previously define.

1066. All the *tors*, as well on *Dartmoor* itself, as on the continuation of the same ridge in *Cornwall*, fall under the case remarked by the author of the *Minerology of the Scottish Isles*; they are rocks which rise like *towers* on the highest parts of the eminences. If, then, they were columns of a mineral substance raised, in a state of *fusion*, through the *strata*, this substance would necessarily have flowed out, unless, according to Mr. Playfair's opinion, in heaving up these *strata*, which consist of *schistus*, *gneiss*, or *grey wacke*, it had remained enveloped by them till it had hardened, and had been afterwards laid open to view, in consequence of the dissolution of that covering by atmospherical actions. Now first, were this the case, the alluvial soils in the wide parts of the vallies of *Dartmoor* should be composed of the rubbish of *schistus*, *gneiss*, and *grey wacke*; while we have seen on the course of the *Dart* that the sediments of that river consist entirely of the same granitic *sand* which still covers those *strata* on the eminences and slopes of *Dartmoor*.

1067. The state of most of the intervals between the *tors* on this chain affords also a proof (which I have



have equally observed in several mountains in *Germany* whereon rise rocks of *granite*) that nothing has been carried off from them since the continents have existed; for they are covered with a great thickness of *peat*. It is in these *peat-moors* that are formed the first rills of the rivers rising in this chain, which is called *Dartmoor*, because the chief of these rivers is the *Dart*; as, for a similar reason, the name of *Exmoor* is given to the high grounds wherein the *Ex* rises. The history of the eminences among which the *Dart* begins its course may be traced even higher; as they still retain their ancient name of *Dartmoor forest*, though at present there is not on the whole of *Dartmoor* a single tree, except a few that have been planted round houses. This is the case with all the great *peat-moors*; they were formerly forests, which flourished for a time, because of the humidity of the soil; but when the trees ceased to have any firmer support for their roots than the *peat*, they were overthrown by the winds, and then covered by the *peat*, as it increased in thickness. Now the *peat* on *Dartmoor*, as well as on the continuation of this chain in *Cornwall*, is formed on the coarse *sand*, of which, before it was bound by vegetation, such quantities had been washed away by the rains; and since the *peat*, which is a vegetable product, has on *Dartmoor* embraced all the eminences of *granite*, it constitutes a new proof, that, since the continents have existed, these eminences have not been covered either by the *schisti*, or their associated *strata*.

1068. Another

1068. Another great question which will here be submitted to the decision of facts, is that of the *stratification of granite*. Dr. Hutton was very sensible that, if granite were a substance which had been raised up under the *strata* in a state of *fusion*, it could not be *stratified*; and he therefore pretended that it was not, as Mr. Playfair has continued to maintain, notwithstanding the positive assertions and descriptions of M. de Saussure, with respect to the *granite of the Alps*: nor is this a case peculiar to those mountains; for all the mineralogists who have described chains of the same kind, in every part of the world, have mentioned the *stratification of the granite*; and I shall myself adduce new examples of it in *Germany*, in the travels which I purpose hereafter to publish. But since examples taken from distant countries have not prevailed, in the mind of Mr. Playfair, against his friends opinion, it is necessary to examine this object in a part of *England* which he has himself visited, and has even considered as affording peremptory proofs of his theory; and hence particularly I was induced to extend my observations into *Cornwall*.

1069. After having thus explained the principal questions which are to be submitted to the decision of facts in the continuation of this journey, and pointed out the phenomena whereby they are to be decided, it will not be necessary for me, in describing the latter, which are very numerous, to apply them directly to these questions, except in particular cases,

July

*July 16th.* I set out in the morning from *Henrock*, with Mr. Hill and one of his sons; these gentlemen, being on horseback, were guides to my driver, who would not otherwise have been able to find the way over the hills. Ascending from *Henrock*, we took a road cut obliquely up a slope, the prolongation of which forms the western side of a large combe, rising to the top of the hills, where one of the branches of the *Teign* has its origin. Mr. Hill pointed out to me this combe, as one of the innumerable proofs of the same nature that running waters have not formed the cavities in which they flow; for the western side of this exhibits strata of *schistus* nearly vertical, without any *blocks* of granite on the surface; while the opposite side is entirely covered with these *blocks*, and has a rock or *tor* of the same stone on its summit.

1070. After proceeding some way on the top of these hills, we turned towards *Moreton Hampstead*, and came in sight of the same valley which we had observed the day before from *Shapter down*; but being now nearer it, and at a greater height, we could see the *Bocey* flowing down the oblique channel already described on the opposite slope. From this elevated point, we had a view of *Moreton Hampstead*, which appeared to lie in the valley; though in reality it stands on an eminence. We alighted to walk down on this side, the slope being long and very steep. When we reached the bottom of the valley, we there found the *Wrey* flowing in a channel which has so little

little declivity, that, in order to make it turn a mill, it has been led from a great distance by a canal cut along the foot of one of the slopes, and thus a fall is obtained: yet the two sides of the valley through which it arrives here are at a sufficient distance from each other to afford passage to the largest of the European rivers.

1071. As we ascended the hill on which *Moreton Hampstead* is built, Mr. Hill made me observe the *growan*, as it is called in these countries; that is to say, the coarse sand, which covers the eminences, and which, as I mentioned § 1062, is sometimes indurated in strata, as is here the case. These *strata* have been cut to make the road; and Mr. Hill shewed me in them a phenomenon, which, as he told me, becomes greater and more important in *Cornwall*; this consists of true *veins*, or fissures, some of them as much as five or six inches in breadth, filled with a *gangue* of quartz tinged by a blackish substance.

1072. By this road, we arrived at *Moreton Hampstead*, built on a rock of *granite*, the houses being immediately founded on this rock, which serves as a natural pavement for the streets: I shall describe this singular place in a future excursion. We proceeded hence to *South Zeal*, a village nine miles distant. For some way, the soil continued to consist of *growan*, its upper *strata* containing *blocks* of real *granite*. The road afterwards passed over the edges of *schistose strata* descending inwards, and following the

the inclination of the slope towards a valley. *South Zeal* stands at the foot of the most lofty of the eminences in *Dartmoor*, called *Cawsand*, or *Cawson*, which, according to COL. MUDGE'S measurement rises 1792 feet above the level of the sea. It was to this eminence that Mr. Hill had proposed to accompany me, in order that I might form a distinct idea of *Dartmoor*; and in our observations on this spot will be found examples of all that I have said above of the general phenomena belonging to this high ridge.

1073. We left our horses at *South Zeal*, and began our ascent towards *Cawsand*, the extensive base of which consists of schistus, and is covered with a great abundance of *blocks of granite*, with some of the blackish stone resembling basalt. There is another hill, also of *schistus*, and lower than the former, which is separated from it by a mere brook, and has its base and slopes covered with the rubbish of its own strata; but no *blocks of granite* appear on its surface.

1074. After we had passed over the base common to both these eminences, and began to ascend *Cawsand*, we found the slope become very rapid; and we soon lost sight of the *strata*, as they were concealed by a very thick loose soil, composed of small fragments of all kinds of stones, covered with grass, through which rise a quantity of *blocks of granite*. Continuing to ascend, we came at last to the *peat*, and its thickness increased as we proceeded, till at

last the *blocks* were almost entirely buried in it; the grass on this peat being tolerably firm, the remainder of our ascent was more easy. After a walk of two hours from *South Zeal*, we reached the summit of the eminence, which we found covered with large *blocks* of *granite*; it is of considerable extent, and there are on it two of the artificial mounts called *barrows*, being circular heaps, formed by the ancient inhabitants of the country; these on *Cawsand* are composed of *blocks* of *granite*, as are those on the mountains of *Daouria*, described by M. PATRIN: Mr. Hill shewed me a place where one of these *barrows* had been opened; but he could not tell me whether any thing had been found in it, which discovered for what purpose it had been constructed.

1075. We advanced to the brow of this eminence on the side opposite to that by which we had ascended; and hence we looked down all around on the immense extent of the *peat* grounds that cover the summit of *Dartmoor*, with no other inflections than those occasioned by the inequality of the soil beneath them. In particular, we had before us a large space, in the centre of which is a pond called *Cran-mere pool*; the title of *pool* has probably been given to this piece of water only since it has been reduced to the size implied by that term; as the former part of its name indicates that it was anciently more considerable, *Cran-mere* evidently signify the *Lake of Cranes*.

1076. Mr.

very high, encircling the large basin of the peat. The *strata* of *Cawsand* being, so far as they are discovered, of *schistus*, as well as those of the small neighbouring eminence, it is probable that the same *strata*, by the angular motions of their masses divided by the catastrophes, have likewise produced these obelisks, which resemble those seen on the *Alps* and other chains of this kind. These eminences on *Dartmoor* are of different forms, some, like *Cawsand*, have an even surface, and their slopes are regular all around, with the peat rising up them; others are irregularly shaped, and are surmounted by *tors*, or rocks of *granite*.

1079. The prospect from the summit of *Cawsand* is extremely interesting, especially when viewed in company with a person acquainted with all the surrounding country, and in weather as favourable as we fortunately had that day; there were indeed some showers, but, in the intervals between them, the air was perfectly transparent. The following are the objects within view from this eminence, as they were pointed out to me by Mr. Hill. On the north, lie the low hills of *Devonshire*, extending to join those of *Somersetshire*; the *Quantock hills* (which I shall describe in the sequel) bounding the horizon on the N.E. On the south, this eminence looks down on a great extent of the peat grounds of *Dartmoor*, covered with grass, and shewing, by the inequalities of their surface, the disorder of the *strata* beneath. On the N.W. towards *Bovey Tracey*, may be distinguished  
many

many of the lower branches of *Dartmoor*, with *tors* and *blocks* of *granite*. On the east, at no great distance, are the *Haldon hills*; followed by those of *Blackdown*, the *Dorsetshire hills* appearing in the horizon; and a part of *South Wales* is seen on the N.W. above the cliffs of the coast.

1080. It was seven in the evening before we came back to *South Zeal*, whence Mr. Hill was to return immediately with his son to *Hennock*; but, before we parted, he had the farther kindness to give me directions for my journey the next day, when I should have an opportunity of observing the extremity of *Dartmoor* on the side next the *Tamer*, with the signs there exhibited of great catastrophes, in the way to a part of the course of the *Lyd*, where that river enters a deep fracture of the *strata*, near which there is a fine cascade, formed by a brook. I then took leave of Mr. Hill with much regret, and set out for *Okehampton*, where I was to spend the night. For some time, I travelled along the base of *Cawsand*, where I continued to find strata of *schistus*, covered with *blocks* of *granite*. When I descended on the *Okehampton* side, I entered a cultivated country, consisting of hills and vales; the *strata*, wherever they appeared, were of *schistus*, inclined inwards, in the same direction as those of the last slope of *Dartmoor*. The town, where I arrived at eight o'clock, is situated at the entrance of a deep and narrow valley, whence issues the western branch of the small river *Okement*.



July 17th. I was to cross the *Tamer* at *Lifton*, and enter *Cornwall*; but Mr. Hill had directed me to quit the high road thither at some distance from *Okehampton*, whence I set out on foot, at eight in the morning, to observe the above valley, sending my chaise forward to wait for me. A little way from the town, I entered a great chasm in the foot of *Dartmoor*, in which, on an insulated mount, stands an ancient castle. I crossed the branch of the *Okement* that issues from this chasm in one of the parts called *stickles* or *fords*; the water was here very clear, and flowed rapidly amidst masses of *dunstone*, over which I walked dryshod. These stones, certainly, have not been brought down by the river, for this rapid part of its course is preceded by a bar of dipping strata of *dunstone*, which produces above a pool of considerable extent, bordered with meadows on the ancient deposits of the river during its inundations. This spot, and all the surrounding objects, bear the impression of a very extensive subsidence of the strata, the deepest part of which forms the valley of the *Tamer*. This will appear from the following description of the disorder of the masses of sunken strata, between the foot of *Dartmoor* and that valley.

EAST. Coming to the place where my chaise was waiting for me, I proceeded in it for some way under the great eminences of *schistus*, on small hills composed of the same strata; and among these I saw a considerable height, covered with grass, the

the entire mass of which consisted of small fragments of *schistus*, as was seen in the excavations made for the purpose of taking out materials to mend the road. There are greater examples of this phenomenon near higher mountains, and in particular, the *Alps*; along which are observed such vast insulated heaps of fragments, as cannot have been formed by any cause in action since the continents have existed: this phenomenon is necessarily connected with that of the *blocks*, as having been produced by the compression of the interior fluids in the *subsidence* of the large masses of *strata*; these heaps of fragments, as well as the gravels and the blocks, having been then ejected from within. However, most of the small hills extending from the foot of *Dartmoor* to the bed of the *Tamer*, are formed of the *strata* themselves, mostly covered with grass; and in the parts where these appear, they have different inclinations, in consequence of the different angular motions of the separated masses during their subsidence. The slopes of the eminences above are intersected with *combes* of different natures, produced by accidental circumstances in those catastrophes: in some of these *combes* are *tors* and scattered *blocks* of *granite*; the surface of others is smooth and covered with grass throughout their whole extent; and some, rising in a gentle slope, are overspread with heath growing on the peat which communicates with the peat moors above.

1082. After proceeding some way, I quitted the road to *Lifton*, and took that to *Lidford*, where I arrived at noon. There, after a few previous inquiries respecting the objects which Mr. Hill had mentioned to me, I set out on foot to see them, and had a very fatiguing walk of three hours, the frequent rains having rendered the path very miry and slippery. This is a district which may justly be called *Alpine*, as it exhibits, on a small scale, the various phenomena resulting from the catastrophes of the *strata* around the *Alps*, and their effects on the course of the waters descending from the heights; I say on a small scale, because here there are no greater eminences than those of *Dartmoor*. From *Lidford* I descended a long slope, having a higher hill opposite to it; the slopes of the two hills meet at the bottom, and their interval, seen from above, appears to be only the bed of a brook bordered with trees; but, on arriving there, a deep cleft is found in the *schisti*, and across it is a bridge with a single arch, resting on both sides against the rock. This is the channel of the *Lyd*, though the river cannot be seen from the bridge, on account of the ash-trees which grow on the lower part of both the slopes, and interweave their branches across the cleft; so that I only heard the noise of its waters foaming among blocks at the bottom of this chasm, which I judged to be about 50 or 60 feet in depth.

1083. At *Lidford* I had been directed to a certain farm-house, where I might obtain a guide to the *ca*  
*ca*

cade which Mr. Hill had mentioned to me. After having passed over the bridge, I crossed the hill beyond it, and came into a vale wherein flow several rivulets; one of these, proceeding from *Dartmoor*, was then limpid, notwithstanding the frequent showers of the preceding days; but the others, formed among the opposite hills, were turbid. At the top of a slope turning towards the valley of the *Lyd*, a space has been excavated to receive all these rivulets for the use of a mill; and a little below, their waters, united in a single stream, form the cascade which I was to see. When I came to the farm, I asked for a guide; and a young girl was sent to accompany me. As the cascade cannot easily be approached above, it is always viewed from a spot below. The slope down to that spot is so rapid, that, though there is a winding path, the descent would be very difficult, if the edges of the schistose strata, inclining inwards, did not form it into steps. At the bottom of this descent, I came into a large space, where I saw the *Lyd* flowing calmly through its own deposits, after having issued from the cleft already described: at the foot of the slope, a great deal of sand has been accumulated by the river, and is now covered with brushwood; the opposite side consists of meadows. The girl told me, that, during great rains and sudden thaws, the *Lyd* still inundates this whole space, as well as other meadows along its course; in the whole of which there is no other defile than that whence the river issues forth into this wide vale.

1084. I then ascended the river nearly to the issue of the *defile*, from which the valley suddenly opens, but only on the left side, with a vertical section of the *strata*, almost at right angles with the direction of the cleft. It is in the recess thus formed, that the brook, after having flowed along the upper part of the hill, falls in a *cascade* down another vertical section of the *strata*, at right angles with the former, from a height of about 200 feet, the asperities of the rock reducing it into foam from the top to the bottom; and this sheet of water, being enclosed between the trees and bushes growing on its borders, produces a very picturesque effect. The whole aspect of the place clearly shows, by the disorder in the sides of the valley, that it has been the effect of the subsidence of a mass of the *strata*; and there are besides two proofs that the brook itself has had no share in the formation of the valley, but that it found this precipice already existing when it first began to flow; one is, that, half way down the *cascade*, there is a *projection* in the rock, from which, without having been able to wear it away, the water falls a second time; the other, that there are patches of *moss* scattered on the surface of the rock, over which the water glides in a *cascade*; whence it is evident that here no erosion is produced. Upon the whole, I found nothing in this part of the course of the *Lyd*, which I had not seen in many places around great mountains, and in their vallies; but it was interesting to find here such characteristic features of those catastrophes of the *strata* by which  
*vallies*

*vallies* have been produced, as I was now approaching the valley of the *Tamer*, in a part much above that where I had observed it in my former journey.

1085. It was three o'clock when I came back to *Lidford*, where I again took my chaise, and travelled four miles over hills of the same kind, before I re-entered the high road to *Lifton*. The last of these hills, composed of soft argillaceous schistus, had on its surface abundance of masses of quartz and of quartzeous schistus. From this I came into a vale covered with meadows, where flows a small stream which falls into the *Lyd*; and hence, ascending the opposite hill, where is a quarry of the slates proper for roofs, I entered the great road from *Okehampton* to *Lifton*, by the village of *Lew Trenchard*.

1086. This road, from the point at which we re-entered it, passes for some way along the top of a hill, whence there is a view of all the country to the north, as far as the sea. From this height, the whole space had the appearance of an undulated plain, gradually ascending towards the high grounds, near *Barnstaple bay*, on which the *Tamer* has its source, and whence that river flows to the opposite side of the peninsula, to discharge itself into the sea on the south. As I descended into this lower space, small hills appeared to rise in it, and I came into a large vale covered with meadows, through which passes the *Tinhay*, a little river proceeding from the northern  
part

part of the foot of *Dartmoor*, and afterwards joining the *Lyd* before it falls into the *Tamer*, below *Lifton*. I crossed the *Tinhay* by a bridge, and then ascended to *Lifton*, which is built on a rock, with an ancient castle on the summit. The *strata* of *schistus* that compose this eminence dip towards the bed of the *Tamer*; and on the opposite side is another hill, on which stands *Launceston*, belonging to *Cornwall*; whence it is evident that this valley has been formed by a great subsidence of the *strata*, leaving these two large masses above the level of the rest. Here the *Tamer* is crossed; and it is impossible not to perceive that, ever since this river first began to flow, it has passed along its present valley, which it has raised to a great extent, by its sediments, now covered with meadows: the point where these are the narrowest has been chosen for the bridge; which is, however, very long, and has a number of small arches, that the waters may run off during floods; and the stream has so little declivity, and consequently has had so little power to excavate its bed, that, in order to obtain a fall for mills, it has been necessary to bring the water from a great distance, by a canal cut along the foot of the hills on the right bank.

1087. In ascending the hill of *Launceston*, no doubt can be entertained of what I have said above, that it has been produced, like that of *Lifton*, by a great subsidence of the *strata*, with the angular motion of the masses remaining at a higher level than the rest. At the foot of this hill of *Launceston* appear

pear the *strata* of *schistus*, dipping, like those of *Lifton*, towards the bed of the *Tamer*; higher up, they become successively less inclined, then nearly horizontal, and at last they incline in a contrary direction; but they are all intersected with fractures, and great partial subsidences; and the surface is so much covered with their fragments, that the inclinations and changes of the *strata* cannot be perceived except in some abrupt sections. The town of *Launceston* is built on the summit of this hill, which is commanded by a very high rock, whereon are the ruins of another ancient castle. I ascended the latter by a rapid slope, on a narrow mass of the strata, covered with rubbish; hence, between the battlements of the old walls, I saw that the hill, almost entirely insulated, is bordered on the northern side by a vale covered with meadows, whence issues the small river *Ottery*, which arrives here to join the *Tamer*.

*July 18th.* The general recommendation which the Bishop of EXETER had been so good as to give me to all the clergy of his diocese, by whom he was beloved and respected, procured me at *Launceston* the assistance of which I had need. Having inquired for the house of the clergyman of the parish, I was taken to that of Mr. JOHN ROWE, by whom, under these auspices, I was very obligingly received. I explained to him what were the objects which I had in view; and as the best means to procure me information, he was so good as to introduce me to  
Dr.



Dr. CARPENTER, the person to whom this part of the country had long been known, and who answered my questions with much readiness. I told him what opinion I had formed on viewing the country from the castle; namely, that neither the *Tamer*, nor any of its branches, of which the *Ottery* is one, had ever flowed at a higher level than they do at present; that, on the contrary, they have raised by their sediments the bed wherein they at first began to flow; and that therefore the mounts dispersed along the course of all these branches are original, and not produced by the erosion of the waters around them. Dr. Carpenter entirely acquiesced in this opinion, which he confirmed by the following circumstances. The *Tamer* and all its branches, from their most remote extremities, flow through a succession of meadows formed on their sediments, down to *Greston bridge*, near which the feet of the hills begin to approach each other; and the *Tamer* there enters a deep and narrow cleft, terminating in the *Hamoaze*. Above this point, the extent of the grounds sloping towards the *Tamer* and its various branches is so great, that during lasting rains and sudden thaws, the defile below *Greston bridge*, the whole breadth of which is then filled by the water, is too narrow to permit it to run off as fast as it arrives; so that its level rises in the space above the defile, where it forms a lake of such an extent and depth, that, as Dr. Carpenter told me, a ship of the line might have room there to go through all her manoeuvres; and at the same time, all the upper parts of the course of the *Tamer* and

and its principal branches form a kind of series of other lakes, in which the water has no sensible current. These are facts very opposite to Mr. Playfair's idea that the *Tamer* and all its branches have excavated their own vallies: they certainly found these intersections in the land, when they began to flow; since which time they have been so far from deepening their beds, that they have raised the bottom by their sediments; and wherever a cascade, like that near *Lidford*, occurs in the course of any of these small branches, it clearly appears that the abrupt sections which produce it had been previously formed by the catastrophes of the strata.

1088. After having spent the morning with these two obliging gentlemen, and received from them the necessary instructions with respect to the continuation of my journey, I set out at noon from *Launceston*, in my way to *Bodmin*. The roads of the country which I had now entered were perfectly known to my driver; but for information respecting the particular objects of my attention, I everywhere applied to persons on the spot. After I had crossed, on this western side of the *Tamer*, several cultivated hills resembling those on the eastern side, the *strata*, also of *schistus*, that compose them having the same variety of inclinations, I entered a vale which divides these hills from a tract similar, on the whole, to *Dartmoor*. I crossed this vale by a village called *Five lanes*, it being a spot where five roads meet. Hence I ascended the high ground just mentioned,  
which

which is completely covered with peat, formed on a great thickness of the coarse sand resembling decomposed granite; but on some parts of the slope I saw appearing *strata* of *grey wacke* or *dunstone*. It is on the slopes only that the *strata* can here be discovered; for throughout the whole extent of this high ground, they are entirely concealed by the peat formed on the sand. Here again, as on *Dartmoor*, insulated mounts rise on the general surface, the inflections of which are mostly gentle, though some are of greater depth: some of the mounts are rounded and covered with downs; others are overspread with a great quantity of *blocks* of *granite*, and have *tors* on their summits.

1089. On the slope above-mentioned, where the *strata* of *dunstone* appear, some blocks of that stone, and of the blacker kind resembling basalt, are scattered on the surface among the blocks of *granite*. The inhabitants of a hamlet situated on this slope are employed in the operation called in this country *streaming*; I saw it here for the first time; and it will become an interesting object in the sequel of this journey. This operation consists in washing the kind of sand already described, in order to extract grains of a very rich *tin ore* which are in some places contained in it. For this purpose, a rill of water must be brought on a slope, and made to pass successively over the surface of the sand, while the latter is, at the same time, stirred up to some depth with shovels; small hollows being made on the  
course

course of the water, wherein the grains of *tin* ore, being the heaviest bodies, sink to the bottom. I shall not enlarge here on this interesting phenomenon, because it cannot be elucidated but by collecting, in different places, all the particulars relating to it, which are connected with those of the *growan*,

1090. All the upper part of these hills is covered, as I have already said, with a great depth of peat, resting on the coarse sand; the stratum of the latter is of very great thickness, and as it is used for the roads, excavations are made in places lying rather low, which afterwards form sheep-pools; large flocks being kept to graze on the peat. Around some of these cavities, are sections of the sand of considerable depth, wherein I saw masses of two different kinds; some of *growan*, easily broken with a hammer, and others of very hard *granite*. I have never seen roads so good as those which are made of this sand; it binds, and is reduced by the rain into a continuous mass, not afterwards liable to be softened by water. This property of the granitic sand, renders it very useful in the *Hartz*, where there is such an abundance of it, that it even forms hills; for there, *dams* of 40 or 50 feet in height are constructed with it across vallies in which torrents flow, in order to raise the level of the water, and to bring it laterally on the wheels of the engines employed in the mines. Provided that these dams are of sufficient thickness to resist the pressure of the water, they contain it as well as any wall could do.

1091. The

1091. The frequent heavy showers, which fell while I was travelling over these eminences, afforded me an opportunity of perceiving the solidity of the roads made of this sand; for they continued quite hard, and without wheel-ruts: and as, on this high ground, I had few objects of observation, the showers themselves, which had lasted for many days, engaged my attention here, as they had already done on *Dartmoor*, the whole horizon being within my view; and they form an object sufficiently interesting to *Meteorology*, to authorize me to introduce a digression respecting them. During the nights succeeding these days, the stars were particularly bright; at sun-rise, there were no clouds, and the air was so transparent, that objects could be distinguished at a very great distance. A little afterwards, some scattered white clouds appeared, which at first were small; but soon growing larger and more dense, the rays of the sun gave them great brilliancy on an azure ground. By these clouds the rain was produced: from time to time, one of them, increasing rapidly in size, descended so low, that at last it concealed the whole horizon; a stormy wind arose, and was accompanied with a deluge of water; after which the sky, interspersed with the same bright clouds, was again cleared, and the air was calm, till the same atmospheric operation was repeated: during this day, the interval between these heavy showers never exceeded a couple of hours. This is so far from being an extraordinary phenomenon, that, on the contrary, it very frequently occurs; and I am surprized that

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the impossibility of applying their hypothesis to it has not been felt by those who still maintain the opinion, that rain proceeds from water *dissolved* by the air, and reduced into a *dry* and *transparent* state; but who are, however, obliged to leave this water subject to the effect of *refrigeration*, for the purpose of explaining *rain*, as *directly* proceeding from it.

1092. Within six or seven miles of *Bodmin*, we came to a vast combe descending southwards, and crossed it in a part where it was already of considerable depth. The side on which we went down into it was scattered with *blocks of granite*, covered with *lichens* in the parts rising above the grass; a proof that they were not suffering any decomposition; and on the same side, rocks of *granite* appeared towards the bottom of the combe: but the opposite side was of a quite different kind, being cultivated on the slope presenting the section of strata of very soft argillaceous *schistus*, which is easily broken by the plough: the summit, formed of the plane of the strata, was covered with grass; but no longer on *peat*, because the *granitic sand* here ceases, and the *peat* on these eminences, as well as on *Dartmoor*, and several mountains which I have seen in *Germany*, is formed only on this *sand*, or on some other possessing an analogous property. This fact corresponds with what I have already said, in the first volume, of an antiseptic faculty acquired by the waters upon certain

tain grounds, by which the combustible quality of plants is preserved in *peat-moors*.

1093. This great extent of ground higher than the rest of the country has another analogy with *Dartmoor*, namely, that many rivers have here their origin, being formed by a multitude of small streams, which descend in all directions. On the southern and broadest side, the waters are collected in the combs more or less deep of the slopes, and continuing to flow, in the same direction, between the low hills, where they are increased by other streams, they are afterwards united in a deep valley, and arrive at the sea under the name of the river *Fowey*, the mouth of which I shall hereafter describe. Another principal river, the *Camel*, or *Alan*, sets out also from these eminences, and has a very remarkable course: it rises as near the northern coast as the *Tamer*, and flows likewise to the south for a certain way, so that I crossed one of its branches in travelling westward; but, when it descends to lower ground, it turns back to the north, and falls into the sea at no great distance from the spot where it had risen on the heights. The course of this river, as traced in the maps, had, made me desirous to observe it near this inflexion: which I accordingly did the next day.

1094. When we came to the western brow of these eminences, I saw the town of *Bodmin* below them, but at too great a distance to permit me to

discern the situation of that place, near which the *Camel* bends its course. In the long descent on this side, I saw sections of the schistose strata, intermixed with others of pure white quartz; and the whole surface covered with grass, was scattered with masses and gravel of the same quartz. As I descended, the town of *Bodmin*, which is situated on a branch of the hills, appeared to rise before me: I arrived there about five o'clock; and after having dined, I walked down to the river, in order to form a first general idea of its course at this point. The observation of the coast of the northern part of the peninsula was the more interesting to me, on account of the reason given by Mr. Playfair for the different directions of the Cornish rivers: I had therefore been very desirous to procure some recommendation in this neighbourhood; and among the letters which Mr. Nott had been so good as to give me, there was one to Captain RODD, at his seat of *Croan*, four miles distant from the sea; whither I accordingly went the following day.

*July 19th.* I set out from *Bodmin* at half past eight o'clock; and in my way to *Croan*, I passed the spot which I had observed the evening before. The road lay along the slope of the hill, towards *Dunmeur*; I did not, however, go so far as that village, but having descended into the valley of the *Camel*, I came first to a stream which proceeds from a *combe* rising towards *Bodmin*, and unites with this river a little below. The *Camel*, having issued

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from a very deep part of its valley intersecting the hills that I had passed on the preceding day, here bends its course round a promontory advancing on its right bank, and flows in a contrary direction along an abrupt section of the hill. The river having, from the time when it began to flow, found wide spaces to spread itself both above and below this promontory, has there deposited the greatest part of the earthy materials which it has detached from the heights, and brought down thus far; and its sediments, sensibly horizontal between the feet of the hills, form at present large meadows. Advantage has been taken of the contraction of the valley in front of the promontory, to build over the river a bridge with several arches, for the passage of the waters during floods; in crossing this bridge, I inquired of some country people whether these meadows were inundated in winter; they told me that this happened more or less, according to the seasons, and that sometimes the whole space was under water. After having passed the bridge, I ascended the continuation of the *schistose* hills which I had crossed in my way to *Bodmin*; and wherever the *strata* appeared, their inclinations were the same as that of the rapid slope descending from a great height down to the abrupt section bordering the meadows; while the opposite side of the valley of the *Camel*, which is much lower, comes down to them with a gentle declivity. This whole western side of the great eminences is intersected with deep combs; so that our road was up and down hill all the

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the way till we came to *Croan* : I fortunately found Captain Rodd at home ; and having explained to him the various points respecting which I was desirous of information, he very obligingly offered me all the assistance in his power.

1095. The first object of my enquiries was this singular course of the *Camel* ; and in order to render it more clear to me, he unrolled MARTYN'S large map of *Cornwall*, on a scale of an inch to a mile, in which I saw the following particulars concerning the rivers of this north-eastern part of the country. About fifteen miles east of *Wade bridge*, where the *Camel* enters the gulph bearing the name of its mouth, and only four miles from the coast, is the highest ground of this peninsula, in which four rivers rise, within a space of but half a mile in diameter : one of these descends towards the east, and has but a short course ; for, turning first to the north, and then to the north-west, it discharges itself into the sea on this same coast, in the small bay of *Farra-bury* : the second flows towards the south-east ; this is the *Ottery*, which, as I have said, falls into the *Tamer* near *Launceston* : the third is the *Imy*, which likewise joins the *Tamer*, but at a lower point : and the fourth is the *Camel*, which first flowing southward, proceeds in nearly the same direction for fifteen or sixteen miles, and then, issuing from its deep valley near *Dunmear*, turns back northward, and discharges itself into the sea by the gulph near *Padstow*, which, because this river enters it, bears

its name. These four principal streams are increased by a multitude of brooks, collected in *combes* evidently produced by the catastrophes of the *strata*; and as a proof of this, wherever the brooks have, at any height, found wide and horizontal spaces in their course, they have there deposited the material which they have brought down with them so far.

1096. This highest part of the peninsula being so near the coast, I was desirous to observe the latter at some point betwixt the spot where the *Came* rises, and that to which the same river returns, by the contrary course, to discharge itself into the sea because, when I had viewed this coast from the eminences above described, I had seen it bordered by a separate ridge of elevated hills, descending from the eastern side towards the gulph of *Padstow*. On my expressing this wish to Captain Rodd, the point which he thought the most proper for my observation was a high cape between two very remarkable coves, *Port Quin* on the west, and *Port Isaac* on the east; because this point commanded a view of the coast to a great extent. He gave me a letter for Mr. GUY, the owner of a farm called *Roscarroc* situated on the interior slope of the hills on this part of the coast; and he had besides the kindness to accompany me on horseback, with his friend M. GLANVILLE, who happened to be then at his house as far as a spot from which he could show my drive the road leading to that farm. He likewise gave me  
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a letter of recommendation to Captain RETALLICK, an officer of the navy resident at *Padstow*, whither I meant afterwards to go.

1097. We proceeded together to the brow of the eminences on which *Croan* is situated, and which are separated from the opposite ridge of hills that borders the coast by the lower part of a large *combe*, following the inner side of these hills, and descending from the east down to the gulph of *Padstow*. Captain Rodd made me observe the steeple of the village of *Endellyon*, on the slope of the opposite hill, as the point towards which my course was to be directed; and he pointed out to me the road across the kind of plain formed by the lower part of the *combe*. Having had occasion to tell these gentlemen, in the way, that the courses of the Cornish rivers, and their openings to the sea, were among the objects which I wished to observe in this journey, Mr. Glanville, who resides at his seat on the southern coast of the county, between the rivers *Fowey* and *Tamer*, invited me to visit him there in my return along that coast from the *Land's end*, as I should find in the neighbourhood many objects interesting to my views: and of this invitation I afterwards availed myself with much pleasure and advantage.

1098. It was about noon when I parted with these gentlemen; and if I had not known that I was so near the sea, I might, as I pursued my journey, have fancied myself in the middle of the continent. The  
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part of the *combe* which I was to cross, three or four miles in breadth, when seen from the heights, appeared a plain, with a ridge of hills rising beyond it and no one could have imagined that the latter, on their opposite side, had the sea at their foot. This then is a new example of those great subsidences behind hills bordering the coast, which form the object of the XIIIth head of the Introduction to these Travels, and cannot be supposed to have been excavated by running waters, because there is not a sufficient extent of lands whereon waters could have been collected to form any considerable stream which will be seen to be the case in this *combe*. When I had descended into it, I found its bottom interspersed with small mounts of *schistus*; in some of these the *strata* were nearly horizontal, and shewed their sections all around, while in others they were inclined towards different points; an evident sign of the subsidence of a large fractured mass, some part of which have been left higher than the rest, as is the case in most of the large vallies; and from the state of the hills bordering the sea, it will appear that these are themselves only masses, which have remained at a still more elevated level, and of which the *strata* have been thrown into the utmost confusion, by the great catastrophes whence has resulted the present bed of the sea. In all this large low space, I saw but two streams deserving of notice; one flowing along the foot of the hill which I had just descended the other, following that of the opposite hill, which cut down abruptly to a great extent. It is not the  
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brook that has produced this steep section; for it here glides slowly through a space nearly horizontal, composed of a marshy soil.

1099. The slope of these hills, which, when seen from the opposite side of the valley or extensive *combe*, appears nearly uniform, is however much intersected, as well by several terraces and longitudinal clefts, as by large combes descending towards the valley; and the cause of these great sinuosities in the surface is easily seen in the disorder of the *strata*, which shew much variety in their inclination. As I crossed one of the small longitudinal vales that intersect this slope, I saw in it a brook, flowing down from the principal heights on the eastern side. Hence I ascended to *Eadellyon*, and arrived at *Roscarrock* about two o'clock. I delivered to Mr. Guy Captain Rodd's letter, explaining what was the object which I had in view: Mr. Guy immediately ordered one of his men to attend me, and leaving my chaise at his house, I set out on foot with this guide.

1100. We first ascended to the summit of the hill, which is of considerable breadth, and then went down the opposite slope as far as the cape mentioned by Captain Rodd, advancing in the middle of a bay eight miles in breadth, and commanding a view of its whole coast, bounded on the east by *Cape Tintagell*, before which lies a rocky island, and on the west by *Pentire point*, a cape on the eastern side of the gulph of the *Camel*. The promontory whence I observed  
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this coast has high cliffs all around it, but is almost the only part of the border of the bay presenting to the sea great sections of the *schistose strata* which compose this ridge of hills: everywhere else, their slopes, though rapid, are in tillage or in pasture nearly to the level of the sea, and even, in some places, quite down to that level. The sea is very deep all round this bay; so that no strand is seen here, only some rocks rising to the surface of the water.

1101. In taking a view of this whole coast and the surrounding hills, it is easy to judge how the *coves* intersecting the former have been produced: they are the lower parts of the *combes* which separate those hills, and terminate at the level of the sea; their form has not undergone any sensible alteration from the action of the waves; for, if we conceive that level to rise gradually even so much as half way up the hills, it is evident that the outline of their borders must still remain nearly the same; a proof that the form of the hills is original; that is to say, that their *combes*, which are prolonged below the level of the sea, are effects of the catastrophes of the *strata*, in the vast subsidence whence has resulted the new bed of the ocean.

1102. The largest *coves*, which are thus the lower parts of the largest *combes*, are ports in this bay; the *combes* themselves affording convenient roads for carts to go down to them and return. On each side of the promontory lies one of these ports; on the eastern

eastern side, to which I came first, I saw *Port Isaac* a considerable way below me; and *Port Quin* is on the western. In these ports are chiefly landed coals for the villages on the hills, and a fertilizing sand brought from parts of the shore farther to the westward. This sand, of which I shall have occasion to speak more at length, is almost entirely composed of shells and corallines, broken and triturated by the waves against the rocks on the coast, as well as those rising to the level of the water; it is here used for manuring the fields, as lime and chalk are employed in other parts of the country.

.1103. Proceeding then to the side of the promontory above *Port Quin*, I saw that port at the bottom of a contracted part of a large *combe*, the sides of which are here very rapid, and even precipitous at its opening towards the sea; but the *combe*, as it rises, becomes much wider, and divides itself into three principal branches, with several smaller inflexions between them, in the form of a fan. The middle *combe*, expanding as it rises up to the summit of the hills, serves as the principal road from this port to the interior part of the country: that which unites with it on the eastern side extends as far as *Roscarrock*, where it is confounded with other inflexions of the hill; and the water of all the springs of these being collected together in a small stream, it is received in a basin formed for the use of a mill; but this quantity of water not being sufficient, that of the springs of the western *combe* has been led into the  
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same basin, across the lower part of that which lies in the middle, by a canal passing under the road. It is altogether impossible that rills like these, formed only on the side of the hills above, can have excavated such wide spaces; and besides, the true cause of these *combes* appears in the situation of the *strata*. Going down to *Port Quin* by the part which is least rapid of the slope of the hill commanding it on the side next the sea, I found this slope formed by sections of the *schistose strata*, inclining towards various points. I saw a great building below for curing pilchards, but not having time to observe it, I returned by the eastern *combe* to the farm of *Roscarrock*, and was three quarters of an hour in walking thither.

1104. The covering spread by vegetation over almost all stony hills, after the first rains had levelled the rubbish, and the seeds of plants had been transported thither by the winds, would have forever concealed the internal state of those eminences, had it not been for the various labours of men. There are still in *Cornwall* very extensive downs, where the softened forms of the surface exhibit scarcely any trace of the inward disorder of the *strata*; but besides the mines, which have discovered this disorder to a great depth, another circumstance has for some years contributed to the same effect on the surface. The increasing price of corn having encouraged the proprietors of these lands to be at the expense of tillage, ground has been broken up, which

as I shall prove in the sequel, had never before been brought into cultivation; and this, with the assistance of the sand above mentioned, has changed, and continues to change, the appearance of the county to such a degree, that if a native of *Corntwall*, who had now been out of it for ten years, should continue absent ten years longer, at the end of that time he would not know his own country. It is not however immediately by cultivation, which is carried on in a very thick loose soil, that the interior part of these hills has been discovered; it is by the want of stones, not only for new houses, but for the inclosures of the fields; the growth of hedges not being favoured by either the soil or the air of this peninsula. Now what I have observed, in this respect, on the hills of which I am speaking, will again introduce a geological question of great importance to the history of the continents, and particularly on account of an hypothesis of the Huttonian Theory.

1105. Plants cannot grow but on a soil which their roots can penetrate; and it is this soil that constitutes our present object. "It is highly interesting," says Mr. Playfair, p. 105, "to trace up, in this manner, the action of causes with which we are familiar, to the production of effects, which at first seem to require the introduction of unknown and extraordinary powers; and it is no less interesting to observe, how skilfully nature has balanced the action of all the minute causes of waste, and rendered them conducive to the general good."

“ good. Of this we have a most remarkable in-  
 “ stance, in the provision made for preserving the  
 “ soil, or the *coat of vegetable mould*, spread out  
 “ over the surface of the earth. This *coat*, as it  
 “ consists of loose materials, is easily washed away  
 “ by the rains, and is continually carried down by  
 “ the rivers into the sea. . . . But it is a fact, that  
 “ the soil, notwithstanding, remains the same in  
 “ quantity, or at least nearly the same, and must  
 “ have done so, ever since the earth was the recep-  
 “ tacle of animal or vegetable life. The *soil*, there-  
 “ fore, is augmented from other causes, just as much,  
 “ at an average, as it is diminished by that now  
 “ mentioned; and this augmentation evidently can  
 “ proceed from nothing but the constant and slow  
 “ disintegration of the rocks. In the *permanence*,  
 “ therefore, of a *coat of vegetable mould* on the  
 “ surface of the earth, we have a *demonstrative proof*  
 “ of the *continual* destruction of the *rocks*; and can-  
 “ not but admire the skill, with which the powers of  
 “ the many chemical and mechanical agents employ-  
 “ ed in this complicated work, are so adjusted, as  
 “ to make the *supply* and the *waste* of the *soil* exactly  
 “ equal to one another.”

1106. The Huttonian system appears to have attracted the approbation and even the admiration of Mr. Playfair, by arguments drawn from *final causes*. On this point our author had not consulted BACON, though he occasionally cites him as a model with regard to the rules to be observed in the study of  
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of nature; for if he had fixed his attention on the latter part of lib. III. cap. IV. of that immortal work, *De augmentis Scientiarum*, he would there have seen what cautions are recommended by this great philosopher in the introduction of *final causes* into *natural philosophy*, on account of the errors into which it is possible to fall, in that respect, until a deep and sufficiently general knowledge of natural phenomena shall have been acquired. Again, if Mr. Playfair had given attention to the facts which I had opposed to this part of the Huttonian system, he would have found in them much better grounds for *final causes* relative to the production of a *soil* proper for *vegetation*; since I have shewn that our continents, when first abandoned by the sea, were already provided with such a *soil*; while, according to Dr. Hutton's system, many ages must have elapsed before *chemical causes*, that is to say, atmospherical actions as explained by him, could have produced it on the surface of continents raised up, as he supposes, by the effect of the same excessive *heat* which had *consolidated the strata*. Moreover, how should *plants* have sprung up on this *soil*, thus rising out of the sea with a scorching heat? But, as I have said, the continents, at their birth, were already covered with such a *soil* in great abundance. For, besides that immense tracts of their surface consisted of *loose strata*, often to an unknown depth, many of which, by the vast quantities of *marine bodies* contained in them, are immediately proved to have emerged from the *sea* in this state, most of the hills  
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p. 369, the *Fowey*, the *Fal*, and the *Hel*, which discharge themselves on the southern coast of this peninsula, as proving, in his opinion, that *rivers* have cut their passage to the sea through the rocks on the coasts, he proceeds in the following manner. “ If “ we would have still clearer evidence, that no “ breaches made *antecedently* to the running of the “ *rivers* have *opened* a way for them, we need only “ look to the opposite side, or northern shore, of the “ same promontory; where we also find a series of “ *outlets*, all originating in the ridge of the country, “ and becoming deeper as they approach the sea, “ but altogether unconnected with the openings on “ the south side; and this could hardly have been “ the case, had they been the *effects* of previous *con-* “ *cussions*, or of any peculiarity in the original *struc-* “ *ture* of the rocks.”

1109. This passage is tacitly opposed to what I had said in my Letters to Dr. Hutton, and have since still farther developed in my *Elementary Treatise*; namely, that, when *rivers* and their several branches began to flow, they found on our continents *channels* which, having been *produced* by antecedent *catastrophes*, were ready to receive and collect their waters. I have shewn, both in that *Treatise*, and in the preceding parts of my *Travels*, that this is an object of the first importance in *Geology*: it was therefore very interesting to observe facts relating to it, in the very country whence Mr. Playfair had  
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then the examples which he indirectly opposed to me. The sequel will shew in what consist the mouths, not only of the rivers *Fowey*, *Fal*, and *Hel*, and all the others that discharge themselves on the southern coast of *Cornwall*, but of those which arrive on the northern shore; beginning by the *Camel*, one of the latter. I have said above, that this river rises at the distance of but four miles from the coast, to which it returns after a long circuit; I have described also its issue from the mountains near *Dunmear*; and I must now give an account of its course from that place to the sea.

1110. As I descended westward from *Roscarrock*, whenever I passed over any of the eminences of that slope, which is every where intersected with small longitudinal vales, I had a view of the course of the *Camel* from *Polbrock*, 13 miles distant from the sea. Now all this space is only an *æstuary*, dividing itself into several branches, which are the lower parts of lateral vales. On observing the great extent of the horizontal soils bordering these *æstuaries*, it is evident that the *Camel*, when it began to flow, arrived at the level of the sea at the point where *Polbrock* is now situated, entering there a long and narrow *gulph*; and that, since that time, the only effect produced by the *sea* and the *river* has been more and more to *fill up* this original *gulph* with their sediments; an effect that will be seen still to continue, with a very perceptible progress. When I had descended into the *combe* which, in the morning, I had passed at a greater  
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distance from the *gulph*, I found that its lower part formed one of the lateral *æstuaries* or original branches of the *gulph*, and was entered by the brook flowing along the foot of the hills which I had descended in coming from *Croan*; and this branch, very wide at the point where I crossed it, has been almost entirely filled up with the sand deposited in it by the tides; there is here a bridge across the course of the latter, the water was rising when I passed over it; and although the sea was not agitated, this water was *turbid* as is always the case with the ascending tide, where there is little depth. There is a great extent of pasturage on the part already filled up, and the grass is continuing to spread over the space which is still covered at high water; the cattle are prevented by a fence from going to feed below that line when the tide is out, lest they should be overtaken by it when it comes in. The level attained by the highest tides, when the wind blows against the coast, determines that of these meadows, which are all perfectly horizontal, and are successively extending at the same level over the part still occupied by the water in this branch of the *gulph*, because the grass that grows on their shelving borders retains the sand brought up by the tides.

1111. At the place called *Wade bridge*, I crossed on a long bridge the principal *æstuary* extending to *Polbrock*; and I saw, both above and below this point, a great extent of marshy meadows, still, for the most part, covered by the high tides; the ebbing waters preserving through them small channels which

which the *Camel* also discharges itself: in these I saw small boats going up to *Polbrock* with the tide. Here already I learnt that the sediments of the tides are more and more filling up these channels, as well as the gulph itself; which is a new instance of this kind of maritime *chronometer*, and affords an additional proof of the small antiquity of the continent, on this very side of the peninsula, adduced by Mr. Playfair as proving that rivers have cut their channel to the sea through the rocks of the coast; an operation which would have required thousands of ages. But it will become more and more evident how contrary this opinion is to facts.

*July 20th.* At nine in the morning I set out from *Wade bridge* for *Padstow*, a small town eight miles distant, on the western side of the gulph, on which I was now travelling; and as this side consists of small hills, I found the road continually ascending and descending the whole way. Notwithstanding the rains of the preceding day, I passed no stream but a rivulet flowing through a *vale* in its way to the gulph; the other intersections of the ridge being only *combes*. These hills are mostly covered with a thick *loose soil*, mixed with coarse gravel and larger masses of white *quartz*: the *strata* of *schistus* being covered by this *soil*, I did not perceive them till I came to the hill nearest to *Padstow*; they are in great disorder, and are intersected by numerous veins of the same *quartz* which is scattered on the surface, some of them being six inches in thickness. It is here again



evident, from the situation and form of the hills, that no external cause could have covered them with so thick a *loose soil*; which is every where in downs.

1112. I arrived at *Padstow* at half past eleven and asking a man whom I met in the street, where Captain Retallick lived, he very civilly went with me to shew me the way: I did not find this gentleman at home; but having left for him Captain Retallick's letter, I inquired for the road towards the sea on the side of the gulph, as I was desirous to take advantage of the fine weather; and going that way or I again met the same man who had shewn me Captain Retallick's house; having observed my disappointment at not finding him, and seeing me now in this road, he accosted me, to ask if I would follow the gulph down to the sea; and on replying that such was my intention, he offered me company, as he said I might easily lose my way. I was very glad to have met with such a gentleman; he proved of great use to me; for he was very intelligent, and having himself been an observer, pointed out to me many things, which I have not remarked had I been alone. I have great concern that this very obliging man, whose name was ANDREW PERNALL, was unfortunately drowned in the gulph some time afterwards, when he was in a boat which was upset by a storm.

1113. We set out at a time when the tide was ebbing; and as we passed over the high.

side of the gulph, I saw many *sand-banks* appearing along its whole extent; and in proceeding farther, I saw also a *bar* at its entrance, which, as the water retired, extended more and more towards the eastern side, and at last joined it, leaving only a narrow channel on the western side, preserved there by the course of the tides. This is the passage for the water of the river also; for which reason alone, though the latter arrives at the level of the sea thirteen miles above, the gulph itself bears in the maps the name of the river *Camel* or *Alan*.

1114. Here I saw the first instance of a phenomenon which is peculiar to this coast, and affords a new *chronometer* of a very remarkable kind. The weather being fine, and the *sand-banks* in the gulph soon drying, clouds of sand arose from them, and were carried by the wind to the opposite coast, on which I saw large *dunes*. Of this phenomenon, Mr. Pernall gave me the following account. When high winds from the N. W. prevail during the spring-tides, the waves raise up and drive the sand-banks towards the eastern side of the gulph; a circumstance which has determined the course of the tides and of the river along the opposite coast, and has preserved the opening of the bar in that part. At low water, when the weather is dry, the same winds carry away the *sand*, and sprinkle it over the lands on the eastern side, where it forms *dunes* of prodigious extent, which increase very rapidly. Within known times, many farm-houses there have been buried under this sand ;  
among

among others, a house belonging to Mr. Pernal's mother-in-law had been thus overwhelmed in his own remembrance. On that part of the coast, which is called *Trenant*, Mr. Pernal pointed out to me the church belonging to the village of *St. Enodock*; tell me that it would, before this time, have been rendered inaccessible, had not its entrance happened to be on the side opposite to that against which the sand is driven, and on which it is accumulated up to the top of the roof, the steeple only appearing above it. The whole church indeed would soon be completely buried, if, to preserve the use of it, the sand flying around it, and settling before the door and some of the windows, were not frequently cleared away. The village of *St. Enodock* is situated in the lower part of the great *combe* descending along the hill from *Roscarrock*, all interspersed, as I have said, with mounts formed by sunken masses of the *schistus*; but near the coast, these mounts are almost totally buried in the sand, which, like the large bar formed at the entrance of the gulph of *Exmouth*, is inhabited by a multitude of rabbits. This astonishing phenomenon of the *sand* carried off the shore by the winds will be seen to extend farther westward on the same coast.

1115. The western side of the gulph is protected from these accidents by the situation of the capes at its entrance. The strata of *schistus* form cliffs along this side, on the brow of which we walked some way. We thus came to an inflexion of the surface of the hill

hill, terminating in a cove; on approaching to examine the latter, I saw a phenomenon shewing the cause of its formation; and when I pointed it out to Mr. Pernall, he told me that he had himself made the same remark. I shall here describe this phenomenon, as it will occur, and even on a larger scale, in other parts around this peninsula, and will indicate a very remarkable effect of the catastrophes of the *strata*. At one of the epochs of those catastrophes was produced here a deep and wide fracture, which was afterwards filled with rubbish; so that, being now covered with grass like the rest of the hill, no sign of it appears on the surface, except the above-mentioned slight inflexion: but the waves, beating against the section of this rubbish in the cliff, have caused it to crumble down; and thus has been produced the little cove, which is continuing to deepen, and on the sides of which are seen the sections of *strata* of very hard *schisti*. Proceeding farther along the brow, we met with a second but more complex instance of the same phenomenon, consisting of two large fractures, converging towards the gulph, and uniting before they reach the cliff; these also had been filled with rubbish, which the waves have caused to crumble down; so that the cove here formed is in the shape of the letter Y; the sections of the *schisti* are seen on the sides of the chasm, and those of the rubbish at the termination of each of the branches, where it is continuing to crumble down. It was here that the cause of the formation of the cove had been remarked by Mr. Pernall; and he told me that, since he had observed

served it, both the branches had been perceptibly prolonged. This phenomenon of the *rubbish* will not excite surprize, after what I have said of its abundance on the hills of *Roscarrock*, where pyramids of the schistose strata are imbedded in it; there, probably, it has also filled up *fractures*, which are not perceived on the slopes, because of the grass that covers them: the *cliffs* only can discover this interior state of the continents, resulting from the catastrophes undergone by the strata while still under the waters of the sea.

1116. We then came to the lower part of a large *combe* descending from the top of the hills; beyond it rises the cape called *Stepper point*, which terminates this side of the gulph, and to the extremity of which I had intended to go on; but as I had mentioned my design of proceeding that evening to *Truro*, Mr. Pernall told me that my time at present would be better employed in crossing the promontory, in order to observe it on the side farthest from the gulph, which I should find very remarkable. We therefore went up this *combe*, and having thus reached the summit of the hill, we descended a little on its opposite side, and arrived on the brow of a precipitous recess in the coast, the lower part of which forms a cove filled up by the waves to the level of the water. The sides of this cove, though very steep, suffer no sensible degradation, for they are covered with grass; Mr. Pernall shewed me a path down one of them, at first in a direction towards the sea, then turning and descend-

descending inwards down to the cove; which affording shelter to boats and small craft, this path has been formed by the sailors, for the convenience of ascending to the neighbouring villages, or going to *Padstow*; and Mr. Pernall told me that he remembered it to have been in its present state when he was young, as he had often then ascended and descended by it.

1117. From the same point, we had a very extensive view of this abrupt coast, which turns to the S.W. where I saw other coves of a similar kind, partly filled up with sand. Here Mr. Pernall told me, what I had occasion afterwards to see, that the sand, very abundant on this side also, is absolutely different from that which is tending to fill up the gulph of *Padstow*, and prevails along the coast to the N.E.: the latter is only common sea-sand; but from this point to the S.W. the sand is of that peculiar kind already mentioned, which almost entirely consists of triturated shells and corallines.

1118. Hence we returned over the hills to *Padstow*, where Mr. Pernall was so kind as to accompany me to observe the port, which would have been filled up by this time, had not a pier been built to stop the waves, and prevent them from driving the sand-banks into it; but the tides tend to produce the same effect; for the vessels which had entered at high water were now lying on the sand. Mr. Pernall then led me to a quarry of the same kind of slate as I had seen at *Launceston*; it does not split into laminæ, but is easily

easily divided into very large flags, of whatever thickness is desired, which are used for paving courts and vestibules. What catastrophes must not these *schistose strata* have suffered, when within so small a distance such different kinds are found at the same level! The great differences in their inclination shew the variety of the angular motions which were undergone by the masses, divided by fractures at the time of their subsidence; and it may be easily comprehended, that the collision of these masses with each other produced that astonishing abundance of rubbish or small fragments, which the motions of the ancient sea scattered over its bed, while subjected to so many catastrophes.

1119. I then went again to call on Captain Retallick, because, having left for him Captain Rodd's letter, I thought it proper to inform him that I was setting out from *Padstow*. I learnt that, being an officer of the Fencibles, he was then with that corps in the market place, whither I therefore went to take leave of him, having ordered the driver of my chaise to bring it there to meet me. I accosted Captain Retallick, who expressed much regret at not having been at home when I had called on him, and at being engaged for the rest of the day; but he told me that, if I would stay till the next morning, he should then be at liberty to attend me wherever I might wish to go, inviting me, in the mean time, to dine with the officers of the Fencibles; and their commandant, who was present, united with him in this invitation; I  
thanked

ed them; but shewing them my chaise, at that  
 nt arriving, I told them that Mr. Pernall, who  
 ill with me, had accompanied me to all the  
 which I had meant to observe, and that I must  
 mediate set out for *Truroe*. However this  
 g proved one of the most fortunate circum-  
 s in my journey. The commandant of these  
 les, with whom I had had no previous ac-  
 ance, and who did not at this time hear me  
 , was Captain PENROSE, who had formerly  
 n officer in the navy, but had now retired to his  
 at *Ethy*, on the southern coast of the penin-  
 near the mouth of the river *Fwwey*; and from  
 ntleman, a little while afterwards, when I hap-  
 , in the course of my journey, to be with one of  
 nds, I received the most obliging invitation to  
 use, accompanied with an offer first to carry me  
 o *Padstow*, where he wished me to see some  
 ena which I probably might not yet have ob-  
 , and afterwards to shew me some very inter-  
 objects around the place of his residence; and  
 invitation I gladly availed myself, as will be  
 a the sequel.

O. At five o'clock, I set out from *Padstow*,  
 he intention of reaching *Truroe* that evening,  
 I should have had time to do, the distance  
 only twenty four miles; but in passing through  
*Stumb Major*, an object there struck me suffi-  
 to induce me to change my plan. Till I came  
 place, I had travelled the whole way over  
 small



small cultivated hills, the soil of which consisted of *schistus*; yet, on stopping at *St. Columb* to bait the horse, I saw the front of the inn built of *granite*, very well hewn: I inquired whence this stone had been brought; and as I learnt that it came from some quarries in a hill to the east, five miles out of the road to *Truroe*, I determined to stay that night at *St. Columb*, in order, the next morning, to visit the quarries.

*July 21st.* At nine in the morning I set out from *St. Columb*, and first proceeded along the high road to a public house called the *Blue Anchor*, situated in a vale, three miles and a half from that town; and on the descent I saw only rubbish of *schistus*, *grey wacke*, and *quartz*. I had been told that at this house I should learn the way to the quarries, which accordingly was shewn me.

1121. On reaching the base of the hill containing the quarries, I quitted my chaise; the driver having received directions to proceed along this hill, and ascend another, in order to return into the *Truroe* road, where he was to wait for me. As I walked up this hill, I found its nature very different from that of the other which I had just descended; for the slope was scattered with *blocks of granite*, lying on loose *growan*. Seeing a great excavation at the top of the most rapid part of the slope, I went towards it; and on arriving there, if I had not known that the stone taken out of it was *granite*, I should have supposed that

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I was entering a quarry of *lime* or *sand-stone*, so regular were the *strata*; a very essential phenomenon, on account of the question raised by Dr. Hutton respecting the *stratification* of *granite*, and the more so, as this county had been visited by Mr. Playfair himself.

1122. In this quarry I found no workmen; wherefore, after having examined it, and observed the *inclination* of the *strata* to be considerable, I advanced farther on the hill, which rises towards the east. I thus arrived at another quarry, larger than the former, where one man only was at work; but he proved to be the very man by whom these *strata* had been discovered; I found him very civil and intelligent; and entering into conversation with him, I learnt the following particulars. His business at first had been to cut, for various purposes, the *blocks* of *granite* scattered on these hills, chusing such as could most easily be worked with the chisel, of which there had been a great many on the surface of the hill where his quarries are now opened, cutting them on the spot of the size and form that were bespoke. After having exhausted all the large *blocks* of this kind within a convenient distance from a cart-road, he sought for those which were buried at a small depth; some of these appeared at the surface, and he found others by sounding the soil with a pointed bar of iron: when, in this manner, he had discovered a *block*, he cleared away the sand around it, and cut it

ing to the dimensions of the piece which he means to detach; along this line, he drives in steel wedges with a heavy hammer, and by striking these in succession, he separates his block, the cleft always terminating at the surface of the inferior *stratum*, from which the block is then detached without any other resistance than that of its weight; and as the *strata* are much inclined, he finds no difficulty in making it slide down to the place where he can most conveniently cut it.

1125. Here then we find in the *granite* the first of the characters of real *strata*; and in this spot appears also the circumstance which has been so well determined by M. de Saussure, as indicative of the *stratification* of *granite*, namely, that the crystals of *feldspar* lie always lengthwise according to the direction of the *strata*. It is in this direction, well known by the workman, (who calls it the *grain*,) that he splits the blocks, when, after having thus detached them, he has occasion to reduce their size; for, in the contrary direction, they break with difficulty, and very irregularly. If then the true characters of *strata* are not here recognized in *granite*, the term of *stratification* cannot be applied to any substance in the mineral kingdom. With respect to the case of rocks of *granite* in which the *strata* cannot be distinguished, a case mentioned also by M. de Saussure, it is equally found in many kinds of *marble*; for example, in those that I have described in *Devonshire*, where the *strata* being of great thickness,

ness, the distant lines which should mark them are lost in the multitude of crevices produced by the catastrophes that have befallen them. The *strata* are indeed more easily distinguished in the rocks of *granite* than in those of *marble*, on account of the position of the crystals of *feldspar*; however, the separations of the *strata* of these *marbles* are known, as I have said, by the quarry-men, as being the parts where the blocks may be detached without any other resistance than from their weight; and they are also known by stone cutters, because it is in this direction that the blocks are most easily split.

1126. Here also we find in *granite* an example of what has happened to so many other *strata*, subsequently to their catastrophes at the bottom of the ancient sea; namely that their ruins have been covered, either by their own *rubbish* or by *loose strata* of a quite different nature. Of the first case, a remarkable instance, with respect to the *schisti*, has been seen (§ 1107) in the hills of *Roscarrock*, on the northern coast of this same peninsula: I have given examples of the second case (§§ 970—979) in the masses of *white calcareous strata* covered by a great thickness of *argillaceous* and *sandy strata*, at *Offwell* and *Widworthy* in *Devonshire*; and as an instance of the different substances found on disordered stony strata, I have mentioned (§ 918) the quantity of *sand* which covers the summit of the *Men-~~ap~~ hills* in *Somersetshire*, though, as those hills are composed of *hard calcareous strata*, it is evident  
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that this *sand* could only have been scattered over them in the sea, after their catastrophes had taken place. Now it is the same with regard to the hill of *granite* of which I am speaking; in viewing its surface, no one could suspect its internal state: it is covered with turf, formed on the coarse *sand of growan*, which I still defer to describe more precisely. Lastly, great numbers of *blocks of granite* of various species are scattered on the surface of this eminence, the highest within a great extent of country; the *strata of granite*, therefore, which are here worked, are the summits of ruins, bearing all the characters of catastrophes; and like those of *schistus*, at *Roscarrock*, it is only by digging through a loose soil that they have been discovered.

1127. After having received this important information from the intelligent workman to whom is owing the discovery of these *strata of granite*, I walked some way over the top of the hill, which is everywhere smooth and covered with turf, and on which I saw a quantity of *blocks of a granite* different from that of the quarries. I was here separated from another ridge of hills, by a vale, where I saw a path leading towards the high road; I took this path, and in crossing the vale, I found in it a *streaming work*, similar to that in the neighbourhood of *Launceston*; the *growan* brought down by the rains, before the hill was covered with grass, being here washed, in order to obtain the same grains of tin ore. Having ascended the hill beyond this vale, I found

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my chaise waiting for me in the *Truroe* road, a little to the north of *St. Michael*.

1128. In following this road, I crossed several ridges of *schistose* hills, separated by *combes* of greater or less extent, where everything indicated the fractures and angular motions of the *strata*, produced by their subsidence towards the present bed of the sea, which I was now approaching on the southern coast of the peninsula. The slopes of the hills, gentle on that side, are cultivated in a soil composed of *schistose* rubbish, covering the planes of the *strata* which descend towards the *combes*, while the opposite side of each ridge presents an abrupt surface, formed by the section of the *strata*. On the gentle slopes, the loose soil that covers the planes cannot nourish anything of higher growth than grass or corn: but the steep sides are clothed with woods or coppices, because the roots of trees easily penetrate the interstices of the *strata* in their section.

1129. I passed, in my road, many *ridges* of this form, and their intervals being only *combes*, I saw no streams flowing there; but as the last hill which I crossed before I reached *Truroe* formed one of the sides of a *vale* arriving from some distance on the westward, I found in the latter a small stream called the *Allen*, which passes through *Truroe*, and is there led by canals to turn a mill in the lower part of the town, whence it falls to the level of the sea; as it enters a branch of the *gulph* extending down to

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*Falmouth.*

*Falmouth.* This *gulph* bears the name of the *river Fal*, as, on the opposite side of the peninsula, that near *Padstow* is still called the *river Camel*. I shall describe these particulars more fully hereafter; one of my views in visiting this southern coast of *Cornwall* having been to examine the truth of those assertions concerning the mouths of the rivers *Fal*, *Fowey*, and *Hel*, which I have already cited from Mr. Playfair's work; and for this purpose I had furnished myself with the necessary recommendations.

1130. After a short stay at *Truroe*, I set out at half past five for *Killiw*, which is situated on the hills to the S. W. at the distance of two miles from that town, being the seat of Mr. GWATKEN, to whom the Bishop of Exeter had recommended me as to his particular friend, and who received me with that cordial hospitality, which, in *Cornwall*, I everywhere experienced. I explained to him my design to observe in detail the long *gulph*, as the inspection of the map had led me to consider it, at the opening of which to the sea *Falmouth* is situated, and which I supposed the river *Fal* to have entered at the same point as at present, ever since it had begun to flow. Mr. Gwatken confirmed this opinion, and offered to show me evident proofs of it, going down with me the next morning in a boat from *Truroe* to *Falmouth*; an offer which I very thankfully accepted.

1131. In order to give me some preliminary information respecting the objects of which I should then have only a passing view, Mr. Gwatken unrolled Martyn's large map, which I have had occasion already to mention, where he pointed out to me the multitude of *combes* and *vales*, the extremities of which form æstuaries on the sides of the large gulph, wherein the tides ascend as high as *Tresillian*, at the distance of ten miles from the sea. If, therefore, the gulph were the work of the land-waters in their way to the sea, the largest stream, that is to say the *Fal*, ought to enter it at that point; while the stream really arriving there, though the assemblage of the waters of all the *combes* that I had passed in my way from *St. Michael*, is not even considerable enough to have a name in the map. This stream enters a long æstuary, uniting below with that at the head of which *Truroe* is situated; and it is some miles lower than this that the *Fal* arrives to join it. Down to their junction, and even below it, the *gulph* is very narrow; then suddenly it becomes much wider. On the western side of the wide part lie the town and port of *Falmouth*; but beyond this point, the western hills, stretching across towards the opposite coast, nearly close the gulph, leaving only the passage, which, because the *Fal* is the principal of the streams that issue through it with the ebbing tides, is considered as the mouth of that river, and thus gives its name to *Falmouth*. Now this *gulph*, as I learnt from Mr. Gwatken, is so far from having been excavated by the land-waters, that



that their sediments, together with the *sand* brought in by the tides and the sea-winds, have almost entirely filled up the lateral æstuaries, as well as a great part of the principal one; an operation which is still continuing. After having obtained this previous information, I left *Killiw*, and returned to *Truroe*, where Mr. Gwatken was to meet me the next morning.

*July 22d.* At *Truroe* I had the pleasure of finding an old acquaintance, Mr. WILSON, a gentleman very well informed of every thing relating to the Cornish mines; and Mr. Gwatken, hearing that I was with him, came to me at his house: they then consulted together in what manner I should begin my tour through the district of the mines; and as I was to spend that night at *Killiw*, it was agreed that one of Mr. Wilson's sons should call for me there the next morning, and accompany me to the first mines, where fresh directions would be given me.

1132. With respect to our voyage in the gulph, Mr. Gwatken had arranged that we should first take a boat at *Truroe*, in order to descend with the tide its æstuary and the narrow part of the gulph; below which one of his friends was to meet us with a sailing boat, that we might follow the wider part to the sea on the eastern side, returning afterwards by the *Falmouth* side, on which we were to land in the cove of *Pill*, three miles from *Killiw*; and here Mr. Gwatken

ken had ordered his horses to meet us, between three and four o'clock.

1133. We embarked at ten o'clock, when the tide was beginning to ebb ; and at this moment, the æstuary, which I had seen dry the day before, with the small river *Allen* only flowing in it, was full of water up to the quay of the town. Formerly, *Truroe* had been one of the ports most frequented in the gulph ; but it is now only accessible to small vessels, from the cause which will in the sequel be circumstantially explained.

1134. It might suffice to have observed this æstuary, to be convinced that the gulph itself, with all its ramifications, had existed from the origin of the continents. This branch, which is two miles in length before it unites with the others, ought, according to Mr. Playfair, to have been cut by the small stream that enters it ; now here the *Allen* flows between hills higher even than those between which it had passed in its way hither, and which should have obliged it to take a different course ; and besides that this part of the channel, instead of having been cut by the stream, is filled up with its sediments and those of the tides nearly to the level of the sea, the hills are of different natures on its opposite sides : Mr. Gwatken shewed me quarries on their summits ; those on the left bank are in a hard *schistus*, which is blown up with gunpowder for rough materials ; and those on the right bank are in *strata* of *sand-stone*, which are  
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worked with the chisel for the fronts of houses. On issuing from this æstuary, we passed before the opening another called *St. Clement's creek*, extending up to *Tresillian*, which is the most remote part of the gulph. This creek is three miles in length; and though the stream entering its head is so small, that, as I have said, it has no name in the map, the width of the valley at its opening, and the height of the hills on the sides, are as considerable here as in the *Truroe creek*.

1135. Below the point where these two æstuaries are united, the gulph becomes wider; and this is the part where it is entered by the *Fal*, arriving from the eastward between other hills. The tide being already low when we came into this wide space, we saw appearing above the level of the water the sections of the *schistose strata*; by which this gulph is shown (still more evidently than that of *Dartmouth*, where I have mentioned the same circumstance) to have been produced by the catastrophes of the *strata*; for, on the eastern side, the slopes of the hills, consisting of the *planes* of the strata, descend towards it with a gentle declivity, and are cultivated on a soil composed of schistose rubbish; while the other side presents steep *sections* of the strata, covered with coppices or woods; and in the lateral parts of the projections, the strata are seen inclining inwards. This is the same phenomenon, with respect to the situation of the *strata*, which I have above described on the opposite sides of the *combes* between  
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*St. Michael* and *Truroe*, and which Dr. Hutton and Mr. Playfair themselves have adduced as a proof of the fact, whatever may have been its cause, that the *strata*, have undergone great changes of *relative level*, with *angular motions* of the divided *masses*; and it has been already seen, by a multitude of examples, that these motions of the masses amply suffice for the explanation of *vallies*, *combes*, and *gulphs*, without the intervention of the *waters*.

1136. In passing before the *æstuary* of the *Fal*, I saw no difference between it and the other lateral estuaries; this river is the most considerable of the streams which enter the gulph, as having a longer course than the rest, and thus receiving the waters of a greater number of *combes* and *vales*; it passes by *Grampond*, and then by *Tregony*, where I afterwards saw it in the course of this journey; at the latter place it originally entered its *æstuary*, at the distance of five miles from the gulph; and I shall show this *æstuary* to be a *chronometer*, by the known progress of the new lands which now occupy a part of it.

1137. Beyond this point, we entered a space narrower than many parts through which we had already passed; then suddenly the gulph became much wider. Here we found Mr. Gwatken's friend, Mr. J. MITCHELL, who was waiting for us with his sailing boat; we entered it, but the wind was absolutely contrary to our design of going down to the sea, and  
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all that we could do, by tacking from side to side, was to proceed far enough to observe the entrance of the gulph. Now there I remarked two circumstances sufficient to destroy all possibility of ascribing its formation to those "united powers of the sea and of the land," to which Mr. Playfair (p. 370) attributes the formation of all *gulphs*.

1138. At the entrance of this gulph, on its eastern side, an *æstuary* opens, which is three miles in length, and is nearly at right angles with the passage of the tides. This *æstuary*, called *St. Mawe's creek*, is the lower part of a large *combe*, and branches between the hills into many smaller *creeks*, which terminate other *combes*. It is impossible to suppose that this kind of lateral opening in the land can have been formed by the waters either of the *land* or of the *sea*; for the former compose nothing more than a brook; and as for the sea, the current of the tides, by which only it could have acted in this opening, has no other effect than to make the level of the water within it rise and fall: thus this *æstuary*, like all the others in the gulph, is almost filled up. Opposite to this lateral recess of the land, the western coast is prolonged by a ridge of hills, which much contracts the entrance of the gulph, and on the extremity of which stands *Pendennis Castle*. How could the *waves* have attacked the lands within this long promontory, while, on the contrary, preventing their entrance on that side, it secures the ships lying at anchor before *Falmouth*? With respect to the land-  
waters,

waters, including the *Fal*, their quantity is so small, comparatively with the width of the gulph, that their effect is lost in that of the tides, which, in the road of *Falmouth*, as well as in *St. Mawe's creek*, produce little more than the rise and fall of the water. All possibility of attributing to the *Fal* itself the opening of its *passage to the sea* is therefore entirely excluded; and I shall now give a general proof that the waters of the *sea* and *land* really produce here a contrary effect.

1139. This proof is found in the history of the gulph of *Falmouth*, which will furnish us with a new maritime *chronometer*: Mr. Gwatken told me, that, for about 150 years large vessels have had in this gulph no other port than that of *Falmouth*; whereas formerly they went up to *Truroe*, which then enjoyed a commerce equally considerable. But by degrees, the latter æstuary, like all others, has been so much filled up, that it is left dry when the tides retire, and can only, therefore, be ascended by small vessels. *Falmouth* having thus become exclusively the seat of commerce, this town is consequently much increased in size.

1140. Within the gulph, at some distance from its entrance, there is a phenomenon which marks the limit of the respective actions of the tides and the land-waters. At this point a bar is formed, composed of sand on the side next the sea; but the sediments of the land-waters are retained on the inner side,

side, where they are intermixed with small marine bodies, chiefly little branches of corallines, detached by the waves from the rocks on the coast, and brought within the bar by the tides. A lucky observation on the borders of the gulph, during the ebb, led to the discovery that this mud might serve as a good dressing for the lands; on which account, all that was accessible at the low tides having been taken up, the same work is now continued under water. We saw three barges employed in it, with the instruments commonly used for maintaining the necessary depth in ports. These are long poles, which have a sack at one end, kept open by an iron hoop; this is dragged along at the bottom, and raised by a windlass, when it is perceived to be full. The operation may be performed 12 feet below the surface: it is therefore carried on in every state of the tide on those parts of the bar, where the depth of the water never exceeds 12 feet; but not on the deeper parts, which, however, are those where the current of the ascending tides brings up these corallines, and where the mud consequently possesses in the greatest degree the fertilizing quality: there the barges work only six hours at every tide, from the middle of the ebb, to the middle of the flood; and this, at the same time, produces the good effect of preventing the increase of the bar.

1141. To the natural causes that tend to fill up this gulph is added another, which renders the sediments of the land-waters much more abundant; this is the operation of *streaming*, whereby the vallies are  
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are artificially excavated, and a great quantity of sand is abandoned to the stream. This is carried on chiefly in a vale, which I saw in a subsequent excursion; the stream employed falls into *Carnan creek*, on the western side of the gulph, the bottom of which has been considerably raised by its sediments, around the opening of that creek.

1142. The weather put an end to our observations; for a heavy rain coming on, obliged us to seek shelter, and the wind, contrary to us in going down the gulph, soon drove us up it into the small cove of *Pill*, where we had originally intended to disembark. This cove forms a little port, at which the ore prepared for smelting in this part of *Cornwall* is collected, and shipped for *Wales*, where that operation is performed with less expense, on account of the abundance of the coal. It is very evident that this recess in the coast, which is not the opening of any stream, has been produced by a greater *subsidence* of the strata in this part of the western side of the gulph. These *strata* consist of a very hard *schistus*, and bear all the characters, not only of this latest catastrophe, but of some anterior to it, in which they were first much fractured, and the fractures were then filled with *white quartz*; I saw some of the veins that were six inches thick in the upper part, but became narrower towards the bottom; and after these fractures had been filled up, the *strata* underwent new catastrophes, with angular motions of their separated masses. It was but two o'clock when we  
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landed, and the horses had not been ordered till between three and four; so that, seeing the rain stop, we determined to set out on foot for *Killiozw*. We crossed several *combes* sloping towards the gulph, the opposite sides of which appeared to me to be of different natures; but the rain having come on again, we were obliged to quicken our pace, and I could not attend to observations.

1143. I spent the evening at *Killiozw*, in a manner very agreeable, and at the same time very useful to me, as I then formed a plan for the succeeding part of my journey, which several circumstances concurred to determine. Mr. Nott had given me a letter of recommendation to the two MR. STACKHOUSES, father and son, at their seat at *Pendarves*, in a district of mines; and Mr. Gwatken considering that the mines whither the younger Mr. Wilson was the next day to accompany me would lead me towards *Pendarves*, which place, at the same time, lay in my way to the *Land's end*, he advised me to proceed thither by that road, and then to return along the southern coast, where, in *Mount's bay*, I purposed to observe *St. Michael's mount*, a kind of island of *granite*, with *schisti* at its base, described by Mr. Playfair as having crevices into which *granite* had been injected while in a state of *fusion*. MR. DAVIES GIDDY, a gentleman who resides at *Tredrea*, not far from that bay, and is particularly acquainted with all the circumstances relating to the mines in this country, happened to be then on a visit to Mr. Gwatken;  
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having read Mr. Playfair's work, and remembering this remark, he expressed his desire to observe *St. Michael's mount* with me; and I agreed with great pleasure to the proposal. It was therefore necessary to fix a time for our meeting on that spot, which was to be at low water, as it is then only that these schisti are uncovered; Mr. Giddy and Mr. Gwatken calculated the time when I might be there; and in consequence they formed an itinerary for me, day by day, according to which I was to be on the coast of *Mount's bay*, opposite to the island, on the 28th at eleven o'clock in the morning. Having made this appointment with me, Mr. Giddy was so good as to invite me to return with him from that place to *Tredrea*, whence he proposed to accompany me afterwards in some other observations.

1144. I am now entering into the district of the mines in *Cornwall*, where I shall be for some time detained, as it afforded me various objects of observation; what I shall relate will but little concern *mineralogy*, a particular science of which the details are inexhaustible; I shall therefore consider it only in its connexion with *Geology*, and here principally with reference to the questions respecting *granite*. It may have been seen in my *Elementary Treatise*, that, since Buffon published his system, a great question has been agitated under various forms, the decision of which is of the utmost importance in the *History of the Earth*; namely, whether it is possible to ascend in that history, by precise *monuments*, to an  
epoch

*epoch* whereat must have commenced the operations of *physical causes*, from the succession of which has resulted the *present state* of our globe. With respect to this object, I have adopted, with full conviction, the system of M. de Saussure, who considered the chemical *precipitation* of the crystals of which *granite* is composed as having produced the first class of our known *mineral strata*; and in the above mentioned *Treatise*, from p. 46 to the end of the *preliminary Discourse*, I have traced the analytical and synthetical steps, by which, in following the track of evident *monuments*, the connexion is established between the *present state* of the earth, and this *first* of the operations produced in its mass by known *physical causes*; whereby a great light is thrown upon Geology.

1145. Among the hypotheses in opposition to this system, the *Huttonian theory* is the most modern of those which deserve any notice, and it contains the greatest number of real facts; but, at the same time, it not only virtually obstructs every avenue to the investigation of any assignable *commencement* of the operations of known *physical causes* on our globe; but the impossibility of such a determination is even one of its tenets. It is supposed in this theory, as I have already had an opportunity to explain, that geological *monuments* lead only to discover a succession, without any accessible beginning, of *continents* formed of the disintegrated *materials* of each other; and that these *materials*, having been spread over  
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the bottom of the sea, and having produced these *mineral strata*, of the same nature as those which, being indurated by an *internal heat*, compose our present *continents*, this same heat, after a certain time, produced *vapours* capable of *raising* these *strata* above the level of the sea. But, during such an operation, this crust of *indurated strata* could not but have been broken, and reduced into a multitude of disunited masses; how then did it happen that these *vapours*, the expansive force of which was no less necessary to support the broken vault than to lift it to this height, did not leave it to fall down again, by their dissipation through the fractures?

1146. It is here that the question enters which particularly concerns the *nature of granite*. Neither Dr. Hutton nor Mr. Playfair have mentioned the above direct objection to their system of *elevation*; but they try to guard against it by raising up under the *strata* a matter in *fusion*, in order to close their *fissures*, and thus prevent the escape of the *expansible fluids*; for which purpose they have had recourse to *granite*, with *porphyry* and other contemporary mineral substances. Now first, if these substances had been thus raised up in a state of *fusion*, they ought not themselves to be found in *strata*; these authors, therefore, pretend that they are not stratified. And yet, besides the positive proofs adduced in the *Elementary Treatise of the stratification* of all these substances, I have here given, in this very country to which Mr. Playfair refers, a new example  
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of the same fact, with respect to *granite*, in the hill near *St. Columb*.

1147. But I intended to verify this hypothesis under another point of view. If *granite* in *fusion* had been raised up beneath the *strata* at the time when they were *fractured* and *dislocated* by their very *elevation*, as it must have been then in a *soft* state, it could not itself have been *fractured*. Now I have been informed that the *veins* or *loads*, as they are called in *Cornwall*, which are acknowledged, in the *Huttonian theory*, to have been *fractures*, filled up with other substances ; that these *fractures*, I say, pass directly from the *schistus* into the *granite* ; a circumstance that alone would overthrow the hypothesis. This then was the principal object which had brought me into the district of the mines in *Cornwall*, and had particularly rendered me desirous to observe *St. Michael's mount*, where Mr. Playfair thought he had found an immediate proof that *granite*, in a state of *fusion*, had been injected into the crevices of the *schisti* ; which, in fact, should have been everywhere the case. This preliminary exposition of the chief objects of my observations in *Cornwall* will much abridge my remarks in the course of my narration.

*July 28th.* Mr. Wilson came in the morning to *Killiw*, whence we set out together at eleven o'clock ; he was on horseback, and I followed him in my chaise. In our way we came to the vale of *Carnan*, where flows the small river *Carn*, which is employed

employed in the great *streaming* work already mentioned, and which enters the gulph of *Falmouth* by *Carnan creek*. It appears that not only the Romans, but the Phœnicians before them, carried on this work in the same vale, and in others similar to it, and that this was all which they knew of the *tin* of *Cornwall*; hence the vale of *Carnan* is almost entirely exhausted: Mr. Gwatken had told me in what part of it the work was still continued near the gulph, and I came that way in my return.

1148. On our arrival at the spot to which Mr. Wilson conducted me, called *Wheal Unity*, (*Wheal* signifying *mine* in the Cornish language,) he recommended me to MR. DAVYS, the captain of these *mines*, who readily undertook to give me whatever explanations I might desire, as well as directions for continuing my journey. Near the *shaft*, in which the pumps work, and by which the materials are brought out, I saw large heaps of the latter, where Mr. Davys pointed out to me the fragments of the *load*, or metallic vein, with its various metalliferous parts; but I was most interested in the fragments of the *strata* crossed by this *load*, among which Mr. Davys shewed me those of the *granite*, wherein they were then following it. I shall not enter here into details respecting this object, because what was told me by Mr. Davys was confirmed to me elsewhere with additional circumstances; and I shall then present the whole under one general point of view.

1149. Taking from hence the road to *Pondarves*, I first crossed a vale, in which is the issue of the *adit* or drain of the above mines. This is the lowest point in its neighbourhood whence it has been possible to pierce towards the shaft, in order to receive the water from the pumps, and thus shorten its column, to spare the force that would be requisite to raise it up to the mouth of the shaft. I then passed over a high hill, beyond which is *Redruth*, a small town built on the opposite slopes of the following vale, near another district of mines to the left of the road. On that side, I saw a hill absolutely insulated, rising from the ground in the form of the roof of a long building, an old tower at one end appearing like the chimney. In several parts of this hill, which is called *Carn Bre*, are seen rocks of *granite*, and on its slope, covered with grass and heath, are scattered a great many *blocks*; as I observed afterwards in passing by it. If Mr. Playfair, in travelling through this county, had been attentive to the phenomena which it offers to the view, he would also have found here an example of what I have opposed to the hypothesis that *granite*, though raised up under the *strata*, and penetrating them in its state of *fusion*, was yet prevented from flowing out as a *lava*, by the *schistus*, with which he imagines it to have been still covered. Since the continent has existed, *Carn Bre*, being the highest ground throughout a great extent of country, can have been exposed only to the immediate action of the drops of rain which nourish the grass that grows on it; thus it cannot be supposed that the  
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rocks of *granite*, rising on this as well as on the other eminences already described, could ever have had a covering of *schistus*, subsequently destroyed by atmospheric causes. In these hills, therefore, appears another of the symptoms, so frequent in this country, of the ruptures and angular motions of all the *strata*, including those of granite.

1150. At six o'clock I arrived at *Pendarves*, one of the places where I particularly experienced that genuine hospitality, on account of which I shall always remember *Cornwall* with peculiar gratitude. Mr. Stackhouse had given up this estate to his son, Mr. E. W. Stackhouse; but was here himself, at my arrival, with his lady and daughters, to spend the summer; and I much enjoyed the very pleasing sight of a family rendered so happy by the union which prevails in it. There are mines in the lands belonging to *Pendarves*; and Mr. Stackhouse has besides had great concerns in other mines in the neighbourhood; hence he is very well acquainted with the interior part of the ground, wherever it has been opened to seek and follow the *loads*. I explained to him the point of view under which these researches interested me: and he was so good as to inform me of many important facts, conformable to what I had already learnt from Mr. Davys, but accompanied with more details. Here therefore, from very certain information, I shall give a general idea of the phenomena of most of the mines of this part of *Cornwall*, as well as of the manner of working them; and the particulars which



which I shall afterwards relate will become confirmations of this previous statement.

1151. The first circumstance which I asked Mr. Stackhouse to explain to me was one that had surprised me ever since I had had occasion to know in what the chief product of the mines of *Cornwall* at present consisted. This county was famous in ancient times, as it still is on the continent, on account of its *tin*; and yet, having become acquainted with some gentlemen who were interested in the Cornish mines, I had heard them speak chiefly of copper. The solution of this difficulty which was given to me by Mr. Stackhouse, will afford a very interesting definition of the nature of the loads.

1152. The mines could not formerly be worked far below the *adits*; the streams of water in the combs being very small, and incapable of moving deep pumps. All the loads come up to the surface, as well on the hills, as on the slopes towards the vales; but their section is there covered with a thick loose soil. When these *loads* were discovered by the first miners, (I shall mention in the sequel by what external signs,) they were attacked from above, and worked to as great a depth as was permitted by the means at that time employed for discharging the waters. Now the only metallic product then yielded by most of these *loads* consisted to a certain depth of *tin*, mixed with a great deal of *iron ore*, which it was  
necessary

necessary to separate from the former; and below this, down to the *adits*, the *tin* ore was mixed with *pyrites*, in this country called *mundic*. This tin, together with the grains separated from the sand by *streaming*, was for a long time considered as the whole metallic product of *Cornwall*. Below the *adits* was found, mixed with the *tin*, another mineral, called by the miners *poder*, which spoiled the *tin* in the smelting; and on account, as well of the increasing quantity of this mineral, as of the difficulty of discharging the waters, they gave up working the *first loads*, and sought for others, which they successively abandoned for the same reasons. Thus, as will be seen, the want of sufficient mineralogical knowledge in *Cornwall* caused the *loads* to be forsaken, at the very point where what is now become the chief metallic product of this country was attained.

1153. The mineral here called *poder* was however known in other parts of *England* to be a rich *copper* ore. About the year 1735, Mr. COSTER, a mineralogist of *Bristol*, who had married a lady from *Cornwall*, came into this county to visit her relations; happening to go to a mine, where he observed this *poder* among the heaps of rubbish, he asked why it was thus thrown away; and the miners telling him that it spoiled the *tin*, he saw that they did not know what it was. He then inquired whether there was much of it in the *loads*; and being answered that, as they went down lower, it increased in abundance, so much as to oblige them to abandon their work, he formed

formed the design of converting it to his own advantage. He told the captains of the mines, that he thought he could make some use of this mineral, provided they would let him have a sufficient quantity of it; and as they said that they could furnish him with a large supply, if there was any profit to be gained by it, he made a bargain with the owners of several mines for the whole quantity taken out thence, at so much per ton, stamped, washed, and shipped in vessels which should land it at *Bristol*. The price agreed on paid little more than the expenses of working; but it afforded means of employing the miners when out of work; and coal being at that time, as I had occasion to say in a former journey, at a low price in the neighbourhood of *Bristol*, because it was still found not far below the surface, Mr. Coster continued for a long time to profit by the ignorance of the Cornish miners, enriching himself by the *copper* which he extracted from their *poder*. But this could not always be concealed: it came at last to be known in *Cornwall* that he had a *copper* foundery; and a Cornish founder, going thither to examine how it was managed, gave an account, on his return, of what he had observed: trials were made; the working of the mines formerly abandoned was resumed; and thus their product, which, in the upper part, had consisted of *tin*, was now changed into *copper*. But after a while, the miners were stopped by the want of running water to move the pumps below a certain depth. They had then recourse to the steam-engines, as formerly constructed, and

and were thus enabled to go on for a certain time; when they were again stopped at the depth below which these engines could no longer act. At last, the steam-engine invented by Mr. JAMES WATT, and adapted to this purpose by the genius of its inventor and of his partner Mr. MATTHEW BOULTON, came, as I may say, to give a new life to the Cornish mines, which have ever since continued to enrich the country by their product in *copper*, the *tin*, still taken out of some mines, now constituting but a small part of the metallic revenue of the county.

1154. I must here stop for a moment, to consider the result of these facts. Had they been known to Dr. Hutton, how could he have supposed the *gangue* of the *veins* to be a *melted matter* which had been injected from below into the *fractures* produced in the *strata* by their *elevation*? For in the first place, according to his system that *granite* was raised up in *fusion* under the *strata*, ought not all these *fractures* to have been filled with the latter substance, as Mr. Playfair believes he saw to be the case with those in the *schisti*, at the foot of *St. Michael's mount*? But besides, substances brought into fusion under the *strata*, by an internal heat of the globe, must necessarily possess the same homogeneity which prevails in the *granite*, supposed to be one of their number. Whence, then could have arisen these differences found in the nature of the *loads*, when they are followed from above downwards? For, to say nothing of the variety of the crystals of *quartz* and *spar* of  
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which the *gangue* is principally composed, the *tin* ore mixed with *iron* ore is here first found at the top in great abundance; below this, the former is mixed with *sulphurous pyrites*; still lower, it diminishes in quantity, and a *copper* ore is found; which at last so greatly prevails, that the *loads* are no longer worked on any other account. And what still farther adds to the impossibility of the above explanation, (as will be seen in the sequel,) is that there are *loads*, within small distances of each other, some of which furnish only *tin*, and some only *copper*.

1155. We shall probably never understand the *specific affinities* which produced the *gangue* of the *veins* in the *primordial liquid*, by successive *precipitations* against the sides of the *fissures* which the *strata* had undergone; because the *composition* of this *liquid* has never existed but once on our globe, and the greater part of its ingredients has been distributed in the *mineral strata* and in the *atmosphere*, the water of the present sea being only its residuum. But our chemical operations give examples of analogous processes, by aggregations of substances successively differing from each other, against the sides of the vessels in which substances contained in liquids, whether artificial or natural, are made to crystallize: and moreover, (as has been shewn by M. Werner with more details than I gave in my first work,) *veins* bear indubitable marks of having been filled by a successive *stratification* against the sides of the *fissures*; and these opposite layers, meeting in the  
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middle of the interval, have there left the spaces wherein are found the *druses* of different *crystals*, that form the ornament of cabinets. There is therefore a clue to this operation, when considered as having taken place in the *liquid* which originally covered the globe; while there is none to the idea that substances in *fusion* under the *strata*, having been *raised up* with them, and introduced into the *fissures* necessarily produced in them by this very operation, should be found differing so greatly from each other, at different heights, and likewise so dissimilar to *granite*, which is supposed to have been lifted up at the same time.

1155. *a.* Against this system of the formation of *veins* by *precipitations* in the *fissures*, an objection had been made, which falls likewise on the Huttonian Theory, and with regard to which that theory is without resource. M. Werner and I had concurred in the above system; and during my travels in *Germany*, (intended for future publication,) I went to see him at *Freyberg*, where he shewed me those phenomena of the *veins* on which he had founded it, similar to others that I had seen in the *Hartz*. The objection in question was deduced from the strong *inclination* of some *veins* of great thickness; whence had been concluded, first, that *fissures* could not possibly have been made in this situation, having such a distance between their sides, since there was no cause capable of *raising* the uppermost mass: and that, farther, supposing that these *fissures* might have been produced

duced by any momentary cause, still nothing could have supported the *uppermost mass* during the time which must have been necessary for filling them with *precipitations* against the *roof* and the *wall*, or the upper and lower sides of the interval. This, I say, is an objection against which the Huttonian theory has no resource, and it has appeared so strong to some mineralogists, that, not perceiving any mode of explaining a formation of the *veins* posterior to that of the *mountains*, they have imagined the latter to have been formed originally *with their veins*; an easy expedient for cutting the Gordian knot; and among other mineralogists, M. CHARPENTIER, who was well informed respecting all the details of mineralogy, and was the colleague of M. Werner in the directorship of the mines of *Freyberg*, adopted this idea. But in my system there is no difficulty on this point, as I shewed in a letter to M. de la Méthérie, who, though himself of the above opinion, yet published my letter in his *Journal de Physique*. The *veins* resulted from the first catastrophes of the strata, in which the *fractures* were nearly *vertical*; and continuing for some time in that position; they were successively filled with their *gangue*. The next catastrophes were more considerable; they produced new *fractures*, with unequal subsidences; the separated masses underwent *angular movements*, and thus the *veins* contained in them were *broken* and *inclined*. I shall return to this explanation, when I describe the phenomena of the Cornish loads; but first I shall relate what Mr. Stackhouse told me respecting the  
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manner in which those *loads* were sought for by the ancient miners, on the summits of the hills, where their section is commonly covered to a great thickness by the *rubbish* of the *strata*; and this will afterwards lead me back to the effects of the catastrophes of the latter.

1156. On some parts of the surface of the hills in *Cornwall* were scattered small masses of *tin ore*, there called *shodes*, which those miners considered as an indication that some *load* was near. When they accidentally found a *shode* in the grass, they marked the spot with a stick, and then carefully examined the neighbouring ground. On meeting with a second, they placed there another stick, and continued the search. If afterwards they came to a third *shode*, or several more, and the sticks with which they had marked all these, appeared to be nearly on the same line, they no longer considered it as working at random, to dig through the loose soil consisting of *rubbish*; and very often, when that was cleared away down to the *strata* themselves, the upper section of a *load* was found on some points of this line. The same mode of search is no longer employed, as I shall relate in the sequel; but some *loads* are still worked, which are known to have been discovered by their *shodes*. This phenomenon shews more and more what has already been proved by examples on the hills of *Roscarrock* and *St. Columb*, that it is not by any of the causes now acting on the continents that the stony hills have been covered with  
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a soil fit for vegetation, which running waters are constantly carrying to the sea, as is supposed in the Huttonian theory; but that this rubbish was produced by the latest convulsions of the strata.

1157. I return to these catastrophes, which, as I have said, broke and inclined, not only the strata themselves, but the veins contained in them, already filled with their gangue. This effect is evident from the changes of relative level in the parts of the veins separated by these fractures, and from the new substances filling up the latter, which, in some countries of mines, are called *false veins*, and in Cornwall, *cross courses*; the reason of the latter denomination is a remarkable one. The direction of the first fractures containing the true veins, or loads, is here nearly east and west; while that of the *cross courses* is, in general, north and south, so that they intersect the loads almost at right angles. Now with respect to these *cross courses*, Mr. Stackhouse gave me the following information: they are of three kinds, distinguished by their contents. Those of one kind, sometimes twenty or thirty feet wide, are filled with a porphyric matter, which is one of the substances called *elwan* in this county; these are commonly termed *quarries*, because, seldom containing any metalliferous substances, they are worked for building stone. A second kind contains various ores, such as lead, antimony, and bismuth; and sometimes these are mixed with tin and copper ores. A third kind is called *flucken*, which is the name given to the *false veins*

*veins* in the mines of *Germany*; these are filled only with *soft clay*, and are very useful in the *Cornish* mines, as I shall soon explain. There is still a fourth class of *fractures*, not in any fixed direction: these, which are narrow and filled with *quartz*, are called *gossens*; and however small the distance between their sides, the *strata* and the *loads* have there also changed their relative level, a change shewing that these fractures, like the others, have passed through all the *strata*.

1158. It thus appears that, in the catastrophes which broke the *loads*, the separated masses of the *strata* containing them underwent unequal *subsiden-ces* and *angular movements*; so that when, in following a *load*, it is found to be intersected by a *cross course*, its continuation beyond the latter must be sought for either above or below the point of its level before this interruption; and most commonly, there is also a change in its *inclination*. These fractures have been considerably posterior to those in which the *loads* were formed, supposed, in the *Huttonian* theory, to have been produced in the act of the *elevation* of the *strata*, and closed by *melted granite*, in order to prevent the dissipation of the *fiery vapour* which *elevated* the mass; but this mass has been also entirely broken through by the fractures forming the *cross courses*: must not then a fresh quantity of *granite* have been *melted* and raised up through the space left under the *strata*, for the purpose of closing these new passages likewise against the escape of the

vapour?

*vapour*? It will be seen, when I shall come to the *loads* themselves, how impossible it is to maintain this idea of the *granite in fusion*; but I must first explain in what manner the *fluckens* are useful in mines.

1159. The first use of this kind of cross course is with respect to the seeking for new *loads*, which is now carried on in the following manner: the clay, being easily pierced through, is removed along one side of the fracture, and it is then seen whether the *strata* are intersected by any other *load*; many new loads, some of them very rich, have been thus discovered. But it is only above the level of the *adits* that this operation is performed; because, at a greater depth, the *fluckens*, even when their thickness is reduced to an inch or two, form the security of particular mines against the waters of those adjacent to them. It is not the same in *England* as on the continent, where the *mines* belong of right to the sovereigns, and are therefore worked under a direction which has more extensive views, and is in all respects more advantageous. Directors of the mines, and bodies of miners with their officers, are kept constantly in pay, and thus maintained in carrying on the work, even at times when the product of the mines is very small; because it is known by experience that, after these periods, during which the expence exceeds the profit, the work, well directed, leads either to the discovery of new *veins*, or to richer parts of the same vein, which abundantly compensate for past losses. But in *England*, as I have already explained,  
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the mines belong to the lords of the manors, who themselves seldom work them; thus they pass into the hands of *adventurers*, who work for their own profit and at their own expense, giving to the lord such a portion of the ore as is agreed on, and who are at liberty to abandon the mine whenever they chuse; a certain space being marked out on the surface of the ground, under which they may work to as great a depth as they shall think convenient. The *loads* commonly pass through several estates; and sometimes also, on the same estate, different parts of the same load are worked by several companies of adventurers. Now if the districts of these different companies do not happen to be separated by *fluckens*, and if one company, coming to a part of the *load* which no longer pays the expenses, determines to abandon it, the pumps being there no longer kept in motion, the water rises and rushes down into the neighbouring mines, where, the load being richer, the work is still going on; and the increased expense of pumping out this additional quantity of water then renders it necessary to abandon the whole extent, as far as the next *flucken*, unless the part which the first company has resolved to give up can yield something towards lessening this increase of expense; in which case, those who wish to continue, agree to purchase the right of the other adventurers.

1160. But to return to the nature of the *granite*, which, in these mines, is our principal object. To that hypothesis of the Huttonian theory, wherein it is

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considered as a *substance in fusion* raised up under the *strata*, I have hitherto opposed only these different kinds of *cross courses*, (including the *gosons*), which, passing through the *indurated granite*, have opened new issues to the interior *expansible fluids*; so that, if those *fluids* had raised up the *strata* in the form of a vault, of which the fissures had been filled up with *melted granite*, this vault would necessarily have fallen in, when new openings were thus occasioned in it. But if the *loads* themselves, which are formed in *fractures* supposed to have been produced in the first *elevation* of the continents, pass also through the *granite* as well as the *schisti*, the former must, at that time, have been as solid as the latter. It is therefore to the *loads* that we must now proceed, in order to examine the *strata* through which they pass; and here again I shall first mention the information given me by Mr. Stackhouse, confirming it afterwards by the particular descriptions of different mines.

1161. The following are, in this respect, the general facts. In all the mines of this part of *Cornwall*, after having followed the *loads* downwards through the *schistus*, or *strata* associated with it, all designated in this country by the general name of *kellus*, the miners have continued to follow them in the *granite*, to as great a depth as they have hitherto attained: moreover, above the point of the junction of the *kellus* and the *granite*, strata of *growan*, that granitic substance elsewhere appearing under the form of a loose sand, are found in some places between  
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use of *kellus*, and are likewise crossed by the *loads*. Mr. Playfair, when he travelled in this country, and informed himself of these facts, which are known to all the miners, could he have persisted in the hypothesis that *granite* was in a state of *fusion* when the *strata* underwent the fractures and angular movements now observed in them? while it is evident that when these catastrophes took place, the *mite*, as I have said above, must have been as *hard* as the *kellus*. These facts might also have guarded against the illusion into which he has fallen at the base of *St. Michael's mount*, where he imagines he has found a proof that *granite in fusion* has been injected into the *kellus* (or schistus) whereof that *rock* consists: which will be the object hereafter of *my* observation.

1162. This summary description of the phenomena at the Cornish *loads*, which determines the true point of observation concerning the Huttonian theory, and not less interesting to Geology in general, may enable me to avoid many interruptions in the narrative of my travels, to which I now return.

*July 24th.* Mr. E. Stackhouse was so good as to take me to *Dolcoath mines*, two miles distant from *Andarves*, which are among those where the work has been the longest carried on; and I here saw a larger steam-engine than I met with any where else on my journey, pumping out the water of a great extent of mines, from the depth of 182 fathom. Mr.

E. Stackhouse here introduced me to the captain of the mines, Mr. JOSEPH VIVIAN, one of the most experienced miners of this country, whom I fortunately found to be an old acquaintance, having had occasion to see him in *London* some years before; and circumstance concurred with Mr. Stackhouse's commendation in disposing him to assist my visit, but as the information which he offered to give in detail required some time to prepare, it was agreed that, in my return from the *Land's end*, I should again visit *Dolcoath* in the way to *Pendarves*; which I therefore fixed the day according to the itinerary already arranged for me as far as *Trevelan*. For the present, I went back to *Pendarves* with E. Stackhouse; and I reserve for the account of my second interview with Captain Vivian all the very important details which I received from him, concerning the mines of this district.

*July 25th.* I was this day to be at *Penzance* which is on the western side of *Mount's bay*; and as Mr. Stackhouse was going to one of his estates to the east of that bay, I set out with him at ten in the morning, that we might proceed together to a place on the road, where he was to shew my driver the way to *Marazion*, or *Market Jew*, a small town on the eastern coast of the bay, opposite to which lies *Michael's mount*.

1163. The road thither passes over small hills almost every where opened for mines, with very great declivities.

declivities towards a wide vale, which separates them from a ridge of high insulated eminences, bordering the coast to the eastward. This vale has the form and the verdure of those in *Devonshire*, but not their decoration of hedges and groves; the sea-winds, which pass from all quarters over this narrow part of the peninsula, are very adverse to the growth of trees and shrubs; but some years since a method was discovered of favouring it, and even of producing woods; as I shall mention in the sequel. In this vale, parallel to the southern coast of the peninsula, begins the small river *Heyl*, which afterwards, turning to the north, falls into a gulph on the northern coast, where it preserves its name to the sea, as the *Camel* does in that of *Padstow*. This is a space, which, when I shall arrive in it, will give me occasion for several remarks. .

1164. After having parted with Mr. Stackhouse, I proceeded to *Marazion*, and descended on a strand extending along *Mount's bay* to *Penzance*, a distance of three miles; it very evidently appears that the formation of this *strand* has cut off a part of the ancient *bay*; and this is also the opinion of the inhabitants of the country. The space thus enclosed, which is about two miles in breadth, is absolutely horizontal; and the parts of it nearest the *strand* that separates it from the sea are still marshes, because the access being closed to the tides by a beach which the waves have raised along the upper part of the strand, the soil is no longer elevated by their deposits.



posites. The waters of the hills encompassing this space, being collected in channels, form two small streams arriving at the sea, one near *Marazion*, the other on the *Penzance* side. As, therefore, the sediments of the land-waters no longer mix with the sea-sand, the winds have raised up the latter in *dunes*, on many parts of the strand.

1165. On my arrival at *Penzance*, I went to call on Mr. THOMPSON, one of the clergymen of that place, who, on the recommendation of the Bishop of Exeter, received me in the most obliging manner; and his general knowledge of every thing relating to this country proved very useful to me.

1166. I was desirous first to know why the large marshes that I had seen along the bay were not drained; since the beach, which, with the wide strand, separates them from the sea, forms a dike no less impenetrable to its waters than to those of the land; so that, by placing sluices at the extremities of the two channels of the latter, they might be carried off at low water, even during the greatest inundations. Mr. Thompson told me that in fact nothing could be more easy; but that there was a moral impediment to it. These low grounds having been divided, and assigned to the proprietors of the nearest lands on the hills, are by them leased out to farmers, on whom would fall the expenses attending the drainage; and some parts would sustain a greater loss of ground than others, as well in making the  
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canals, as in securing them : now the farmers, whose leases are nearly expired, do not chuse, by paying a proportion of these expenses, to contribute to the advantage of those who would still have a long time to enjoy the benefit ; and if some parts were left exposed to the inundations, they would endanger the safety of all the rest. This has been shewn by experience : one of the farmers had collected the waters on his own ground in a canal passing under the strand with a flying sluice ; but, during a great inundation, his dike was broken by the waters of the neighbouring marshes. This great extent of land abandoned by the sea cannot therefore really be enjoyed, till the owners shall themselves unite, and carry on the work in common.

1167. Mr. Thompson informed me of another interesting circumstance. At low water, trunks of trees are sometimes found in the sand of the strand ; whence it has been supposed, as well here as on other similar coasts, that the sea gains upon the land ; while all the other phenomena evidently shew it to have retired from the space which I have just described. These trees grew in the marshes, as was at first the case in peat moors ; they were blown down by the winds, during some long inundation, when the ground was softened to an extraordinary depth ; and this muddy soil sliding constantly down the shelving shore towards the sea, the trees were carried along with it as far as the place where they now are found, which is separated from the marshes by the  
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very wide beach, still sensibly increasing, as Mr. Thompson told me, both in breadth and height. This is the same phenomenon which I have described in *Torbay*; and which I have likewise shewn on a very large scale in the bay of *Bridgewater*, where, at the same time, I have explained its cause.

1168. In my way to call on Mr. Thompson, I had passed before a house, the front of which they were then building with a *granite* composed of small crystals, like that of the hill near *St. Columb*. I wished to know whence this *granite* was brought; and Mr. Thompson was so good as to go with me to inquire of the workmen, who told us that it came from a large insulated eminence, called *Tregonning hill*, one of those which I had remarked in my way from *Pendaroes* to *Marazion*; that around the foot of that eminence, were found, buried in a soil of rubbish, large masses of this *granite*, divided into *strata*, of which they shewed us the thickness in the stones brought thither for the building; and that, when one of these masses was exhausted, others were sought for. The resemblance of this state of the *granite* to that of the *schistus* on the hill of *Roscarrock*, of the *white lime-stone* in the hills of *Offwell* and *Widworthy*, and of the *granite* itself on the hill of *St. Columb*, very much interested me; and as *Tregonning hill* is not a great distance from *Tredrea*, I determined to ask Mr. D. Giddy for more particular information on this subject.

1169. Mr. Nott had given me a letter of recommendation to Mr. J. VINICOMBE, a fellow of *Pembroke College, Oxford*, who was accustomed to spend his summer vacations in the neighbourhood of *Penzance*, at the seat of his friend Mr. ROSE PRICE. On inquiring for the former gentleman, Mr. Thompson told me that he was then in the country, and shewed me from his window *Kenegie house*, the residence of Mr. Price, situated on a hill which appeared to me to command a general view of the bay, and of the low lands above mentioned. As it was still early, I inquired of Mr. Thompson the way to the house, and walked thither; Mr. Vinicombe not being at home, I left for him Mr. Nott's letter, with a note to inform him that he might hear at Mr. Thompson's where I was lodged; and I walked on to a part of the brow of the hill, whence I discovered the whole breadth of the peninsula; of which, from these first observations, and those of the following days, I shall here give a general description.

1170. Two ridges of hills, advancing from the northern side, border a spacious tract of low ground, wherein the part of the gulph which has been filled up is very easily distinguishable by its horizontality. I accosted some people of the country, and asked them what was the general form of the low ground which I saw extending towards the north; they told me that there was no remarkable eminence on it, the whole way to *St. Ives bay*, on the northern coast; all the high hills being on the east and on the west,

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at a considerable distance from each other, except in this part, where they approach nearer, and border the meadows. The eastern ridge of hills, which I had here before me, terminates at *Marazion* in *Mount's bay*, and I scarcely perceived its indentations from the spot where I stood; but the western ridge, stretching farther to the south, and forming the western side of this bay, has many promontories; *Penzance* is situated on the extremity of one of these, which descends almost to the level of the sea; and a more distant branch terminates in *Cape Kinniell*, at the entrance of the bay.

1171. The promontory of *Penzance* separates two coves, where I saw the same phenomenon which I have already described in the gulph of *Padstow*, but on a larger scale. The head of each of these coves is formed by the section of a mass of *rubbish*, filling up a large fracture of the *schisti*; and the crumbling down of this rubbish, occasioned by the actions of the waves and of the land-waters, has produced these deep recesses in the coast, on the sides of which are seen the sections of the strata. I must here repeat what I said respecting the former phenomenon of the same kind; because, from these new instances, and others that I shall soon have occasion to describe, this will appear to be a very remarkable feature of some parts of our continents. In the state to which the surface of these continents had been reduced antecedently to their birth, the bottoms of the vallies, as well as the summits and the slopes of  
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many hills, consisting of stony strata, were covered by a thick soil composed of *fragments*; and as there is little motive for digging through this soil, unless when it is supposed to conceal sections of *veins*, or when masses of stone are sought in it, the present phenomenon is never perceived on the surface. But in the parts which, by the vast subsidence that produced the present bed of the sea, became the border of the new continents, that is to say, the *cliff's* on their coasts, wherever the rupture has taken place across some great fracture which had been filled up with *rubbish*, the *section* of the latter appears. In the instances already given, on the north of this peninsula, in the gulph of *Padstow*, and here in *Mount's bay*, on the south, these fractures are in *schisti*; but, at the *Land's end*, I shall give another example in *granite*. Signs of the great subsidence, whence has resulted the present bed of the sea, appear also very evidently in *Mount's bay*, by the masses of the *schistose* strata which border both its sides, and are seen to a great distance under the water; their points shew themselves above the *sand* now tending to fill up the above mentioned coves; and a bar formed of them at the extremity of the promontory of *Penzance* has served as a foundation for a mole, by which its port is secured from the waves that enter the bay.

1172. The recess produced, on the south of *Penzance*, by the crumbling down of the great section of rubbish, has been much more deepened than that on the opposite side, having been more exposed to the

the waves; but they now no longer attack that rubbish, because of the sand which has been accumulated in the cove, and even blown up in *dunes* by the wind. A metalliferous vein having been discovered under the water, between this cove and *Penzance*, some bold adventurers undertook to open a mine there, of which Mr. Thompson gave me the following account.

1173. This was called *Wherry mine*, and lay on one of the *porphyric cross courses* already mentioned, much resembling the *granite*, but with this difference, that, instead of *mica*, it contained grains of *tin ore*. This *cross course*, which, according to its denomination, intersects the direction of the *loads*, has been traced, (as I was afterwards told by Mr. Giddy), in the interior part of the country, where it might be easily worked; but it is no where rich enough to pay the expenses, except in the part near *Penzance*, where, at low water, it was observed to be very rich; and there, the following means were employed. A kind of large tub without a bottom was first prepared, so high that the waves of the highest tides could not pass over it; the lower part of this tub was inserted in the *cross course*, as near the water's edge as possible, their junction being sufficiently secured with brick-work and plaister to be impenetrable to water. At the top of the tub was placed a windlass to draw up the materials detached within, and a bridge was made from thence to the shore. The mine was then opened; and after the miners had descended to a certain

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 certain depth, they continued to work horizontally, in the direction of the *course*. Beyond a certain point, some water began to appear in the mine; which rendered it necessary to place on the shore a steam-engine, with the machinery proper for moving a pump. This submarine mine was worked for a long time, and produced a good deal of tin; but some years before I was there, during a violent storm, the masts of a vessel, which had been driven from its anchorage, struck the bridge, and broke down the exterior edifice: the mine was consequently soon filled with sea-water; but this was not much regretted, because, a little while before, a vein of *cobalt* had been met with, and the air of the mine had become unwholesome.

1174. After having observed the spot where this mine had been worked, I went back with Mr. Thompson to his house, and found there Mr. Vinicombe, who, on returning to *Kenegie*, had received the letter which I had left for him, and was come to offer me, from Mr. Price, every assistance in my intended observations, even as far as the *Land's end*. Nothing could have been more favourable to my views than this obliging offer; and it was settled that these gentlemen should call for me at *Penzance* the next day.

*July 26th.* Mr. Price and Mr. Vinicombe, with Mr. LAMBERT, an Irish gentleman, came in the morning to *Penzance* in a sociable, with saddle-horses



horses following; because the road from the *Land's end* along the southern coast of the peninsula, by which we purposed to return, is not passable in carriage. We set out at ten o'clock, taking the direct road to the *Land's end*, eight miles distant. Mr. Price had provided every thing which could conduce to render our excursion a party of pleasure; and as for the objects themselves, those only who have been on the spot can fully comprehend how fortunate we were to have had such fine weather for observing them; so that I shall always remember this day as one of the most agreeable which I spent during the whole course of my journey.

1175. There is no beauty in the surface of this part of the country; for the natural product of the heights is only a thin turf, interspersed with furze, heath, and fern, on a great thickness of the coarse sand of which I have so often spoken, and many *blocks of granite* are scattered over it. But cultivation is beginning to extend also on these hills, many parts of them being already in tillage; and I here again saw a circumstance which I have before described in the countries of *Mecklenburg*, *Holstein*, and *Sleswigh*, namely, that, when lands are newly brought into culture, before the plough can pass, many parts of them require to be cleared of *blocks of granite*; and these blocks are employed in making enclosures for the fields. It does not, at first sight, appear so surprising that *blocks of granite* should be found here as in the above countries, which consist entirely of sand

sand to as great a depth as they are known ; while, in this part of *Cornwall*, almost the whole mass of the hills is of *granite* ; however, the *blocks* here scattered on the surface do not the less proceed from the catastrophes which that mass experienced, while still at the bottom of the sea : for in this narrowest part of the peninsula, separated from the rest by the low grounds between *Mount's bay* and *St. Ives bay*, none of the causes in action since the birth of the continents can have occasioned the dissemination of the blocks : and the form of the hills, as well as their interior parts, will be seen to bear the impress of the catastrophes of the *strata*, during which these fragments were thrown out.

1176. The quantity of *blocks* which, before the surface can be brought into tillage, it is here necessary to clear away, affords a new example of what I have answered to the objection made against the *chronometer* deduced in my former works from the progress of agriculture, which is continually extending into countries hitherto uncultivated, and shews the small antiquity of the human race on our present continents. It had, I say, been objected, that, considering the revolutions of empires, the countries, now in a wild state, might formerly have been cultivated. But in most of the countries where agriculture has, for a long time, been making a known progress, one of the obstacles to that progress consists in the masses of stone, which it is necessary to remove from the surface, because they would impede the  
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plough; now had these grounds ever before been cultivated, such masses would no longer be found in them.

1177. All the surface of this part of the peninsula is intersected with *combes*, which, on all sides, grow wider as they descend. It is impossible to suppose with Mr. Playfair, that these channels have been cut by the waters now collected in them; for the extent of the summit is not such as to have allowed any stream to be formed on it. Besides, symptoms will presently appear of catastrophes sufficiently great to afford an adequate explanation of these inflexions of the surface. The road for some way rises, except when it crosses these *combes*, till it reaches the highest point, whence it descends towards the village of *Trevescan*, where begins the cape known by the name of the *Land's end*. At this village we quitted the carriage, which went on to wait for us near the *Logan stone*, on the southern coast; and we walked down a rapid slope covered with grass. Some years ago, a gentleman who came to see this spot, having arrived at the village on horseback, was rash enough, notwithstanding the advice which was given him, to persist in riding on to the rocks; his horse fell, and rolled down the slope; the rider was so fortunate as to be thrown off on one side; but the horse continuing to roll on to the precipice, there fell from point to point of the rocks, and was dashed in pieces before he reached the water. As a caution to future rash adventurers, the figure of a horse has been traced on the

the turf with a deep incision, which is cleared out from time to time, in order to preserve it as a monument.

1178. Those who have seen the *Needles* of the *Isle of Wight* may have some idea of the form of this cape, but by no means of its grandeur, and of the astonishment excited by the whole of the scenery of this coast: it revived in my mind the sensations which had been excited by the sight of the *Aiguilles de Châmoûny*, around the *Mer de glace*, and the Alps; for besides the resemblance between those *Aiguilles*, and the peaks of granite rising on the border of this coast, the sea, very deep before the latter, and when we viewed it nearly calm, reflected, like that icy lake, various shades of a sapphire blue, according to the position of the sun.

1179. When, with some previous knowledge of geological monuments, this extremity of the peninsula of *Cornwall* is attentively observed, it is impossible not to be struck with the idea that the bed of the sea is the effect of a vast *subsidence*, in which the *strata* were broken off on the edge of what, by the retreat of the sea towards the *sunken* part, became a *continent*. With respect to this, I have demonstrated, under the XVIIIth and XIXth *Heads* of the *Introduction* to those Travels, that the sea cannot possibly, in any manner, have changed into *abrupt* coasts those which originally descended towards it with a *gentle declivity*; so that the former

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are necessarily sections of the *strata* produced by fractures at the time of the *subsidence* of the parts now constituting the bottom of the sea before them: and under the XX1st *Head*, I have shewn, that, wherever the cliffs consist of *stony strata* which crumble slowly down, the sea is commonly still deep at their foot, because the fallen materials have not yet accumulated on its bottom in a sufficient quantity, to appear at the surface of the water. Lastly, I have already had occasion to explain, and to shew by many examples, that the sections of *combes*, and of large *fractures* filled with *rubbish*, which appear in the *cliffs* on the coasts, prove these *combes* and these fractures to have already existed on the continents at their birth. Now all the above characters are observed around this extremity of the peninsula of *Cornwall*.

1180. All the *cliffs* of this coast, which are very high, bear marks of a *fracture*, with a *subsidence* in its front of the separated parts of the *strata* of *granite*, the sea being there very deep, except at some points which I shall mention: these cliffs shew no impression of the action of the waves; and the only cause of their degradation is, that the whole mass of the *granite* being here split in various directions, the water entering the crevices detaches the masses, which, as being in front, are not impeded from yielding to the effort produced by its congelation in winter. And this, according to the original state of the rocks, has produced, by a greater demolition

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tion of intermediate parts, not only capes, but many insulated pyramids of *granite*, resembling druses of crystals, which form the surprising scene above-mentioned.

1181. The materials fallen from these rocks into the sea do not yet any where appear near its surface; so that no strand has been raised at their foot, except at two points on the opposite sides of the cape of *Land's end*, where, in the section of the coast produced by the subsidence of the bed of the present sea, two very wide fractures of the strata, filled with rubbish, had been brought to view from the top to the bottom. On the top of the hill, these fractures are not indicated by any external signs, except indentations covered with turf; so that they would not have been known to exist, but for their section on the side towards the sea, where the attacks both of the waves and of the land-waters having caused the rubbish contained in them to tumble down, coves have been formed, like those already mentioned, at *Madstow*, on the northern side of the peninsula, and *Penzance* on the southern. Here it manifestly appears that these coves are increasing in depth by continued falls of materials, the accumulation of which has produced a strand within them; and on their sides are seen the sections of the *strata* of *granite*, as is the case with those of *schistus* in the coves before described. This phenomenon leads also to the explanation of another circumstance on the hill above the cove on the south of the cape, which is

wider and deeper than the other ; namely, that there is a part of it where the surface is marshy, irregularly descending from the upper part of the great slope down to the brow of this cove, and intersected by crevices with progressive subsidences of the separated parts, the lowest of which I saw ready to crumble down. I went on this marshy soil ; and tracing its line by the steps thus formed in it, I perceived that it followed that of the fracture, and that springs oozing from the sides of the latter penetrate and loosen the rubbish which fills it up, and which consequently yields the more easily to the cause of gravity, whereby it is impelled towards the point where it crumbles down successively into the cove.

1182. The bed of the sea itself, in front of this extremity of the peninsula, exhibits several signs of the subsidence whereby it has been produced ; among which are many small *islands* or rocks of *granite*, being parts of the sunken strata remaining higher than the rest. There is, in particular, a small archipelago of this kind at the distance of two miles from the cape of *Land's-end* ; and on the highest of the rocks which compose it is a light house under the care of two men, who have need to be endowed with a great deal of patience, and very few wants. During great storms, especially from the west, the waves at high water pass over these little islands, and strike the foot of the light-house ; so that it is then almost impossible for a boat to go on shore there. These men are therefore obliged to lay in provisions, as if they

They embarked for a long voyage; for they are sometimes two or three months without any communication with the land: I was told that after a period of that length the preceding winter, they had been observed to hang out a black flag, as a signal of great distress; on which a boat had ventured to go to them with provisions, and found that they had been for several days without either biscuits or water.

1183. Another indication of the catastrophe, which, in producing the present bed of the sea, has left its effects impressed on the border of the continents, consists in two capes, to the southward of that of *Land's-end*, which is the most projecting. These capes, very high and almost abrupt on the side towards the sea, have signals on their summits. Now here it is clearly seen, that a great subsidence has taken place on the land-side; for these capes are nearly islands, being united to the coast only by very low isthmuses. We observed this in going up to one of the signals; for the slope on the land-side is formed by the plane of the *strata* of *granite*; while that on the side towards the sea, where the greatest subsidence has taken place, is formed by their section, and is covered with large *granitic blocks*, which have evidently not been produced since the continent has existed, for their intervals are covered with grass, on a soil of rubbish. A lieutenant of the navy, who had the direction of this signal, had made advantage of the state of the latter slope, by cultivating all the spaces of sufficient extent between the blocks as  
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kitchengardens, where we saw a variety of vegetables, and among others cucumbers, which were thriving very well; and he had raised flowers in such of the smaller spaces as were most sheltered from the winds by large blocks; there were some very fine myrtles and geraniums, which had stood the winter in that spot. But of all these monuments of catastrophes, the most considerable are the *Scilly islands*, consisting also of *granite*, and forming a large archipelago, twenty-four miles distant to the west; some of them are of sufficient size to be inhabited: from the signal was shewn to us the situation of this cluster of islands, which was distinguishable by a small misty appearance on the horizon.

1184. It is not surprising that the bed of the sea consists here of *granite*, without any covering of *schistus*, since this extremity of the peninsula is entirely composed of it. This is one of the examples which has shewn me, that though, in a great many parts of the bed of the ancient sea, the *granitic strata* were covered with *schistus*, *grey wacke*, or *gneiss*, and the latter subsequently with *calcareous* and *sandy strata*, (as is the case around the *Alps* and many mountains in *Germany*) yet, in my *Letters to Prof. Blumenbach*, I had too much generalized this succession of different kinds of *precipitations*; for in several parts of *Europe* and *Asia* there are large spaces in which the *granite* forms the surface, covered only by loose soils of various kinds, and sometimes even without any covering.

1185. We mounted our horses at *Pensana*, in order to ride, where the ground would permit, along the top of the rocks which command the sea on the south, as far as the cape called *Castle Trereen*, whereon is the *Logan stone*. We were often obliged to alight and walk, on account of the intersections of the surface, and the abundance of large *blocks*; and in some parts, we even found it difficult to lead along the horses; but whenever we could approach the brow of the rocks, we were fully recompensed for our trouble, by the sight of the fine pyramids of *granite* which border the coast, and around which the sea is so deep, that the blue sky with the clouds being reflected in it, they appeared as if suspended in a serene atmosphere.

1186. In approaching the cape of *Castle Trereen*, of which for some time we had a side view, I could not but be much struck with its appearance: it consists of a cluster of granitic pyramids of a prodigious height, rising from a common base, and resembling the towers of a gothic castle; but when we reached it, my surprise was still greater. Behind this steep coast begins a large *combe*, descending eastwards, and opening on the same coast. We first went down into the upper part of this *combe*, which appears to form the moat of the castle, under the outer wall, composed also of rocks of *granite*. There we left our horses, and entering a winding cleft in these rocks, we came out on a grassy space, where, by Mr. Price's orders, a table-cloth had been spread, with an excellent

cellent cold dinner; but the scene which there suddenly opened to our view was so magnificent, that for some time it engrossed our whole attention.

1187. We had before us the pyramids of the cape called *Castle Trereen*, the sky forming the background; on one of them is the *Logan stone*, to which the access is difficult, and would even be dangerous to many people, as a narrow ridge is to be ascended, with precipices on both sides: we did not attempt this; but Mr. Price had sent for a man of the country, who was accustomed to rock the stone; he was already at his post, and began the operation soon after we arrived. There is in the pyramid a division, which, at the point where the stone happens to be placed, is exactly of the proper breadth for a man to lean with his back against the solid part, while placing himself in the posture of a chimney-sweeper, he presses with his feet against the stone: it moves with the pressure, but in a degree perceptible only to the man himself, who yields when the stone returns, being used to its oscillating motions, and renews the pressure every time that he feels it receding from him; and thus, by degrees, the oscillations become very visible: from the spot where we had placed ourselves, we saw them increase, and they continued for some time after the man had ceased to press against the stone.

1188. There is a great difference between individuals, with respect to the manner in which their attention

attention and feelings are excited by the objects of nature. When the man was about to rock the stone, I had seated myself on the grass, near the opening of the defile by which we had entered this space, it being an elevated spot, immediately opposite to the object of our attention, and commanding a full view of the stupendous scene around it. While I was admiring the whole of this prospect, I heard some noise behind me; and turning my head, I saw a gentleman issue from the defile, followed by a lady in a riding-habit; they asked me whether this was the place where the *Logan stone* was to be seen? I shewed them, on the opposite rocks, the man who had taken his station there; and having told them to fix their attention on him, because they would presently see him set the stone in motion, I again turned my own eyes towards it: as soon as it began to oscillate perceptibly, I looked back, intending to point it out to the curious strangers—they were gone. It was quite enough for them to have been in the place where the *Logan stone* stood, and to be able to say that they had seen it. In fact, that very evening, meeting them again at the inn at *Penzance*, where I was lodged, I asked the landlady who they were; she told me that they were travellers come from a distance of two hundred miles to make the tour of *Cornwall*; and that they had been much pleased with that day's excursion, especially with having seen the *Logan stone*. There are many people who observe the objects of nature in a similar manner; but it is to themselves only that this is attended with

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disadvantage, provided they do not publish systems respecting the phenomena of which they have thus snatched merely an imperfect view.

1189. I examined attentively the state of granite in the pyramids surrounding this spot; as it is composed of large crystals of *feldspar*, I can easily apply to it the very just remark of Mr. Saussure, pointing out a sure mode of distinguishing the lines of the separation of the *strata* from those produced by fractures, which often intersect the former. I was thus led to discover, by the position of the long crystals of feldspar, that the division into pyramids was produced by *vertical fissures* passing across the *lines* of the *strata*. I had seen the same phenomenon in many mountains in *Germany* particularly in those of the *Giants* in *Silesia*, where it is attended with a singular circumstance, which I found here also, though in a very small degree, and will afford an explanation of the *Logan stone*. On the above mountain, there are rows of granite columns, consisting apparently of piles of *blocks*; these are evidently the effects, first of fractures in the mass of granite, with the subsidence of some intermediate parts, and subsequently of the actions of wind and other atmospheric causes on the parts remaining as columns, which have corroded the angles both externally and in the separations of the fragments of the *strata*; thus reducing these fragments into rounded masses of which each pile is at present composed. This is the case of the *Rocking stone* in *Ca.*

: *Trereen*; though the strata of the pillar to which it belongs are not so deeply corroded in their situations as those on the *Giant's mountains*, except that this uppermost mass is thus rounded, and separated from the mass beneath, on the convex surface which it rests.

10. I do not comprehend how Mr. Playfair, in speaking of the slow descent of stones along slopes, and of the greater erosion on their uppermost side, while enumerating the various mechanical means which he has devised to effect their *migration*, can have taken this *Logan stone* as one of his examples. See his works, p. 397, "If the waste on one side of this great mass shall exceed that on the opposite in more than a certain proportion, . . . .the equilibrium of the *Logan stone* will be subverted, never to return. Thus we perceive how motion may be produced by the combined action of the decomposition and gravitation of large masses of rock." This is undoubtedly; but, in the first place, it does not explain how these masses could have arrived at the top of the slopes, whence he supposes them to have descended by this combination of causes; and in particular how the *Logan stone* came to be placed on the elevated rock: as for its subversion, which might easily be effected by the cause above imagined, it would be a final subversion, for the stone would then fall to the sea.

11. In the *granite* of which this promontory consists,

consists, we observed fractures filled with *quartz*, mixed with large masses of black *schorl*, forming long needles: one of these veins is two feet in breadth; and we saw in it excavations made by ancient miners, who had expected to find here tin ore. All these rocks have a singular appearance of antiquity, which combines with the whole of the romantic scenery to recall the memory of the Druidical ages; they are covered with a species of bissu, long and rough to the touch, forming a kind of hoary beard, and shewing at the same time how little effect has been produced on them by atmospherical actions.

1192. From the most projecting part of this cape to which we could advance without ascending the pyramids, we saw deep intersections in the cliffs, formed by the openings of *combes*, sloping down to the coast; among others, that which I have mentioned as descending behind *Castle Trereen*, and of which the lower part terminates on the eastward of the cape, whence we had a view of it, in a gulph called *Penbeth*. A brook, formed by the springs oozing out of the sides of the *combe*, falls into this gulph. We crossed it, near its mouth, as we were returning hence towards *Penzance*; and we saw that it flowed over rubbish covering the bottom of the *combe*, which bears all the characters of a large fracture partly filled up, like those already described near the *Land's-end* and *Penzance*; as appears also from the high rocks bordering its upper part on the side next the  
sea,

a, and seeming, as I have said, to form advanced fortifications for the defence of *Castle Trereen*, a name probably given to the lofty extremity of this cape, because its pyramids, from a distance, resemble the towers of a gothic castle. There is in these *combes* a great quantity of the sand which I have so frequently mentioned, and of which the nature will, in the sequel, be determined by new phenomena; here again it is in some parts mixed with veins of tin ore, and is washed by means of the rocks that are formed in the *combes*.

1193. After having crossed several *combes*, which ascend towards *Mount's bay*, we arrived at *Penzance* at eight in the evening; and here I experienced a new instance of Mr. Price's kindness. He had sent to engage Mr. Martin, captain of the lines of a part of the district through which we had passed, to come to his house the next morning; and on finding his answer at *Penzance*, Mr. Price invited Mr. Thompson and myself to spend that day at *Penegie*.

*July 27th.* Mr. Thompson's avocations not permitting him to go early from *Penzance*, I left for my chaise, and set out on foot at ten o'clock, with the intention to take a nearer view of that horizontal soil which I had seen separated from the bay by the strand already mentioned. After having passed over bridges across two small streams descending from *combes* on the western side of this space,



space, I followed for some time its meadows intersected by ditches, till I came to a zone, which on this side borders the hills, and is now cultivated, the new soil having here been sooner raised above the level of inundations. I thus arrived at *Gulvall*, situated on the foot of the hills; whence ascending to *Kenegie*, I had an extensive view of the low grounds which here cross the peninsula, and in which the village of *Ludgroan* is situated; and this space, open to the sea on both sides, is so low, that, if it were possible for the level of the latter to rise but a few fathoms, the part of *Cornwall* extending from hence to the *Land's end* would become an island. It is evidently impossible to believe that this space has been excavated by a river, as Mr. Playfair supposes, with regard to all the sinuosities of this peninsula; for the small streams, which, in rainy seasons, are formed here by the rivulets descending from the hills, have, on the contrary, raised the soil by their sediments, now covered with meadows. But the appearance of the slopes of the hills which border this space proves, beyond all doubt, that it is the part where the *strata*, during their catastrophes, have sunk to the greatest depth; these slopes being formed into irregular terraces, one below another, in consequence of subsidences more and more considerable towards this space, which is itself interspersed with hillocks, shewing the summits of masses of *strata* here swallowed up.

1194. When I arrived at *Kenegie*, I found Mr. Thompson

Thompson and Captain Martin already there; and Mr. Price having been so good as to explain to the latter what were the principal objects of my inquiries, he had sketched on paper several examples of the manners in which *loads* are displaced by *cross courses*, in various kinds of *strata*. One of these examples was taken from the northern coast, to the east of the low space above-mentioned in the district of *St. Agnes*, where the loads are chiefly in the *Kellas*; and that of the mine *Wheal Pink*, in particular, has been followed through those *strata* to the depth of 120 fathom. This *load* has been intersected by three *fractures*, filled with different substances: the highest of these is a *gossan*, being filled, but not entirely, with *quartz*, which, having been accumulated at the same time on the opposite walls of the *fracture*, has advanced from both sides towards the middle, where it has united at some points only, leaving many cavities lined with prisms of *rock crystal*. This is one of the phenomena on which M. Werner and myself have separately founded our common opinion, that *veins* have been filled with their *gangue* by successive *precipitations* in a *liquid*. This first *fracture* is about a foot in breadth; the next is three feet, and the lowest, six: the two latter are *fluckens*, being filled with soft clay.

1195. The inclination of these *fractures* or *cross courses* being in an opposite direction to that of the *load*, they have occasioned unequal subsidences in the masses of *strata* on both sides, and consequently

in the *load* itself. When, in following the *load* downwards, it is found to be intersected by one of these *cross courses*, it is not met with at the same level on the opposite side; it is *higher*; which circumstance, in this country, is called a *heave*, as if the *cross course* had *raised up* the *load*; while it shews only that the mass of *strata* above the *fracture* has undergone a greater *subsidence* than that below it. The changes of relative level of the parts of the broken *vein* on the opposite sides of these *fractures* are more and more considerable in proportion to their depth: the change in the upper one being seven fathom, in the next fourteen, and in the lowest twenty-one. Having here detailed the effects of the *fractures* subsequent to the formation of the *loads* on one of the latter, which is entirely in *kellas*, it will be sufficient for me to say, that the same effects have taken place on all *loads*, whether, as here, wholly in *kellas*, or, as will be presently seen, wholly in *granite*, or, lastly, when the *loads* pass from *kellas* into *granite*.

1196. Captain Martin entered afterwards into details respecting the *loads* in the western part of the peninsula, separated from the rest by the low space, which I have described as crossing it from north to south; a part very different from the eastern, as will be seen in the following abstract of the account given me by this experienced miner. In this western part, wherever the *granite* rises to the surface, the *loads* are entirely in it. This is the case with two *loads* near

near *Cape Cornwall*, one called *Wheal Makin*, in the parish of *Madern*, the other called *Dingdong*, in that of *Gulvall*; both of which had been followed to the depth of 180 fathom, the whole way through *granite*. These *loads*, having their direction from east to west, descend towards the south forming an angle of 22 or 23 degrees with the vertical; when they deviate from the vertical in this manner, they are said to *underlay*. At *St. Just*, on the side next *Cape Cornwall*, there are two *loads* in *granite*, belonging to the mine *Wheal Cock*; one of which contains only *copper* ore, and the other only *tin* ore; and very near these to the north, at *Botallack*, another *load* contains both those ores:

1197. In this part of the peninsula, the *loads* in many places, begin above in the *growan*, a substance which, from the phenomena that will successively appear, seems to consist of the latest granitic *precipitations*. It is in fact a species of *granite*, but its crystals are easily separable; and Mr. Playfair has probably confounded it with true *granite*; when he speaks, in the note to p. 396, of "the rapidity with which the *Cornish granite* wastes." The *growan*, certainly, is very rapidly decomposed; but the true *granite*, forming the rocks on the coast, and also containing the above-mentioned *veins*, is very hard. It is extremely probable that the last *precipitation* of the *growan* kind was the coarse *sand* composed of granitic crystals, and not indurated, of which I have so long delayed to speak; this has hap-  
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pened in many places with regard to common *sand* ; *strata* of *sand-stone* being frequently found covered with *sand* of the same kind remaining loose. That this granitic *sand* is in a similar case, will soon appear from a very striking phenomenon ; namely, that, in the same mine, loose *growan* occurs twice between *strata* of hard *kellas*, the whole mass being intersected by a *load*. In this country, it is observed that the *loads*, when passing through the *growan*, are inclined on the side next the slope of the hill ; and that they are intersected by *fluckens*, those *cross courses* which are filled with soft clay.

1198. It is evident then that a great change has been here produced in the respective situation of the *strata* ; a change connected with the catastrophe by which this part of the peninsula has been nearly cut through, from *St. Ives bay* on the north, to *Mount's bay* on the south. On the west of that line, the *loads*, from the surface down to the greatest depth that has yet been attained, are all in *granite*, or in the *growan* associated with it ; while on the east, the upper part of all the *loads* is in *kellas*, which increases in thickness, proportionally as it is more distant from the transversal division of the county ; so that the *load* of *Wheal Pink*, above described, twelve miles to the eastward of *St. Ives bay*, is, as I have said, in *kellas*, down to the depth of 120 fathom. The variety of effects in these catastrophes is also evidently shewn by the difference of *inclination* in the *loads* : on both sides, their *direction* is east and west ;  
but

in the eastern part, they descend south-  
 any in the western part descend towards  
 ; and the latter are the richest in tin ore.

I shall place here some farther circum-  
 elonging to the *loads* ; and first, respecting  
*thickness*, which is very unequal : for some-  
 ose that were at first very wide, when fol-  
 ther laterally or downwards, are found to  
 so far as to be reduced to an inch in thick-  
 : expence of working them then exceeds the  
 being necessary to make way in them by  
 ne sides, which are called *walls* ; and if the  
 ers lose the hope that such *loads* will  
 en, they abandon them. Sometimes also a  
 le it preserves an equal breadth, diminishes,  
 terally or downwards, in the quantity of its  
 product ; and if this continues to be the  
 he expence exceeds the profit, the adven-  
 re likewise abandon the work. Lastly, such  
 a *load* as pass through *kellas* are observed to  
 richness according to the colour of the  
 which change, in the same masses, from a  
 ey to a reddish tint ; the *load* being found  
 st, when passing through the latter. This  
 ance, which indicates the influence of the  
 the *veins*, according to their nature, on the  
*precipitations* formed against them in the  
 sures, is a phenomenon often observed in  
 untries, when the same *veins* pass through  
 kinds of *strata*.

1200. The load of the mine *Wheal Cock* at *St. Just*, and that of the mine *Powelbarrow* at *St. Agnes*, pass under the sea; so that they are worked, not only below its level, but actually beneath its waters: Captain Martin told me, that having, in his youth, worked as a miner, he had, in the mine of *Powelbarrow*, heard the noise of the waves, at low water, rolling the stones above his head. In the mine of *Wheal Cock*, the water of the sea filtrates through the strata, and must be carried off by pumps.

1201. The above is an abstract of the information which I received from this experienced miner; Mr. Thompson confirmed it from his own observations; and though I shall have much to add to this statement in the sequel of my travels, it is already sufficient to allow me to deduce precise conclusions with regard to the two hypotheses of the Huttonian theory; namely, that *granite* in a state of *fusion* was raised up under the substances stratified on the bottom of the sea; and that the *fractures* produced in the *strata* during this elevation, and now forming the *loads* or *veins*, were filled up with other materials in *fusion* injected from within, which constitute their *gangue*. With respect to the first of these hypotheses, I do not comprehend how Mr. Playfair can have continued to support it, after having been in this county. He acknowledges that the *loads* have resulted from fissures, and he knows that they pass into the *granite*, as well in the parts where it is covered with *kellus*, as in those where it rises to the surface.

surface. Now it is impossible to suppose that the *granite* could have undergone the same *fractures* as the *kellas*, unless it had possessed, at that time, the same solidity.

1202. From the facts above stated, it is equally impossible to support the hypothesis that these *fractures*, supposed to have been produced by *elevation*, have been filled up by other substances injected into them in a state of *fusion*. For first, if any substance had been thus introduced into these *fractures*, it should have been at the very moment when the *strata* were *raised* by the internal effort; and what substance could then have been brought thither, except the *granite* itself, supposed to have been in *fusion* at that time? Mr. Playfair believes that he has seen proofs of its having been injected into the fissures of the *schistus* at the foot of *St. Michael's mount*, one of the objects which had brought me into *Cornwall*, and which I soon afterwards observed; but were this really so, it would be nothing in comparison with the *loads* and *cross courses* in this country, wherein, however, no *granite* appears. Besides, we have seen above two *loads* very near each other, yet differing in their metallic products; which could not be the case, if their *gangues* had proceeded from the same furnace, throwing up the melted materials immediately from beneath the *strata*. Lastly, another consideration embraces this whole object. It has been seen that the *loads*, or rather the *fissures* in which they have been formed, are sometimes so much contracted as not to exceed



ceed an inch in breadth; now, to have rendered it possible for materials in *fusion*, raised from beneath the *strata*, to ascend through these narrow passages, expand as they came into a wider space, and thus arrive at the surface, the whole mass of the *strata* must at that time have been in the state of *red heat*; for otherwise these materials, cooling as they rose, would have clogged the passage; which is sometimes the case with *lavas* in the spiracles of volcanoes, and occasions eruptions in the sides of the cones: and then, what number of ages must not have elapsed, before continents, emerging with this degree of heat, could have afforded nourishment to plants and animals! Mr. Playfair cannot accuse me, as he does the author of *The Mineralogy of the Scottish Isles*, of forgetting the mass of the *schisti*, which he supposes to have been raised up over the *granite*, and destroyed, since that time, by atmospheric actions: for I have already had occasion repeatedly to prove, that in no part where the *granite* of this peninsula now appears at the surface, could it possibly, at the birth of the continents, have been covered by the *schisti*.

1203. I now proceed to the phenomenon of *St. Michael's mount*, which seems at first to give to these hypotheses some appearance of probability. Mr. Playfair, after having adduced some cases where himself and other observers have imagined they have seen *granitic veins* in *schistus*, continues thus, p. 317. "The last instance I have to mention from my own

" observation, is at *St. Michael's mount* in *Cornwall*.

‡

" That

“ That mount is entirely of *granite*, thrust up from  
 “ under a very hard *micaceous schistus*, which sur-  
 “ rounds it on all sides. At the base of it, on the  
 “ west side, a great number of *veins run off* from  
 “ the *granite*, and *spread* themselves like so many  
 “ *roots* fixed in the *schistus*: they are seen at low  
 “ water. In the smaller *veins*, the *granite* is of  
 “ very minute, though *distinct* parts; in the larger,  
 “ it is more highly *crystallized*, and is undistinguish-  
 “ able from the mass of the *hill*. Besides the above,  
 “ *Cornwall* probably affords many other instances  
 “ of the same kind, which I have not had an oppor-  
 “ tunity to examine.” From this description, there  
 remains no room to doubt that the *veins* here spoken  
 of really consist of *granite*, and that Mr. Playfair  
 has actually *seen* them *run off from the granite* of  
 the *mount* into the surrounding *schistus*, as plainly  
 as the *roots* of a tree are *seen* to pass into the  
 ground. This, therefore, was to become the object  
 of my particular examination.

1204. I have already said that having spoken,  
 when I was at Mr. Gwatkin's, of my intention to  
 visit *St. Michael's mount*, Mr. Davies Giddy, who  
 happened to be then at *Killiw*, had expressed a wish  
 to observe it with me. In order to be able to cross  
 on foot from the coast to the mount, and to see the  
*schisti* of the latter uncovered, it was necessary to  
 be there at *low-water*; which circumstance had de-  
 termined our rendezvous at eleven o'clock in the  
 morning of the 28th of July, when Mr. D. Giddy  
 was

was to arrive there from *Tredrea* on the east, and I from *Penzance* on the west. Happening to mention this rendezvous at *Kenegie*, Mr. Vinicombe desired to be of the party; and we accordingly agreed to meet at ten o'clock the next morning, he on horseback, and I in my chaise, at the point where the road from *Kenegie* joins that from *Penzance*, on the strand of *Mount's bay*, to the west of *St. Michael's mount*.

*July 28th.* Mr. Vinicombe and I met at the time appointed, and we arrived together at the part of the coast connected with *St. Michael's mount*, almost at the same moment as Mr. Davies Giddy. The tide being out, we passed on foot into the island, along a slip of land which shews the state of the *schisti* around this *granitic* mount. The sunken *schisti*, as I have already said, form the visible bottom of this bay wherever the sea is shallow, which is particularly the case on the west of *St. Michael's mount*, as far as *Penzance*; on the east of the island, the water is deeper. In subsiding on the western side, the broken *schisti*, have undergone angular motions; their *strata*, divided into many successive masses, are inclined towards that side; and it is one of these masses which, at low water, unites the island with the land, forming here the foot of *St. Michael's mount*. We crossed over to it on the lowest part of this *schistus*, which the waves have covered with gravel, and thence ascended to the highest part, where there is no gravel, except in some fissures.

1805. The first subject of our remarks here was the impossibility that Mr. Playfair could have seen the "*veins running off* from the *granite*" of this mount, "and spreading themselves like so many "*roots* fixed in the *schistus*;" for along all this side of the island, where the *schistus* or *kellas* appears, its junction with the *granitic* rocks, which rise above it, is absolutely concealed by a heap of *blocks* of *granite* of such a size, that it was impossible for us to pass over them in any part, or even to advance among them sufficiently to discover on what base they lie. We then fixed our attention on the *veins* in the *schistus*, where it was uncovered; of which Mr. Playfair says, that, "in the *smaller*, the *granite* " is of very minute though *distinct* parts," and that, "in the *larger*, it is more highly crystallized, and " is *undistinguishable* from the mass of the *hill*." This is by no means what we observed; for we saw two kinds of *veins*, perfectly distinct from each other in their nature, though intermixed: most of these veins are of *white quartz*, entirely pure, whatever be their breadth, sometimes not less than four or five inches; while the few others, not larger than the former, which are among them, and which Mr. Playfair has likewise taken for *granite*, have but a very imperfect resemblance to that substance; and the following is a direct proof that they have not been formed by an expansion of the *granite* of the *mount*.

1806. The observation of these first phenomena having rendered us the more attentive to all the surrounding

rounding objects, we considered the *granitic rocks* which rose above us ; and we saw in them the most complete proof that what has the appearance of *granite* in the *veins* of the *schisti*, is not the same substance which composes the *rocks* ; for these are themselves intersected by *veins* of both the classes above described, namely, of pure *quartz*, and of *pseudo-granite* ; the latter being no less certainly distinguishable from the *granite* through which it passes, than from the *schistus* ; whence it is evident that the *fissures* in the *granite* must have been contemporary with those in the *schistus* below. And here again appears an example of the difference that often exists in the same *veins*, when they pass through different kinds of *strata* : this is here observable in that part of the vein which in *Cornwall* is called *Capel*, and on the continent, *salebanque* ; which is a first stratum adherent to the sides of the *fissures*, of a nature different from that of the *gangue* which has afterwards filled them up. Now the *veins* of *pseudo-granite*, in the *granite* of the rock, have a *capel* of pure *white-quartz* ; while those in the *schistus* have a *capel* of pure *mica*, about two-tenths of an inch thick, the laminae of which are at right angles with its direction, and are very brilliant. The *veins* themselves are unequal in their breadth, diminishing in many parts ; and where they are reduced to two-tenths of an inch the whole breadth is occupied by the two strata of *mica*, shewing their separation in the middle. The *fissures* which cross both the *schistus* and the *granite* are nearly in the direction  
of

of east and west: the granite has crumbled down very much on the southern side, the last masses having separated themselves at the points where there have happened to be veins of the *pseudo-granite*; and its *capel* of *quartz* has in many places remained attached to the face of the rock, which has thus the appearance of an old wall retaining in some parts a coating of plaster.

1207. We followed all the western side, without finding any point at which we could ascend to the foot of the *granitic-rook*, it being every where rendered inaccessible by heaps of large *blocks* of *granite*; but the scene changed on the southern side, where the bed of the sea, instead of being formed of *schistus*, consists of sunken masses of *granite*, which are in part covered by the high tides. Here we saw the same *veins* of *pseudo-granite* and of *quartz*, as, on the western side, we had observed in the *schistus*; the *capel* of the former, however, consisting no longer of *mica*, but of *quartz*.

1208. This island belongs to Sir JOHN ST. AUBYN: the castle on the summit of the rock, with the bold outline, as well of the rock itself as of its base, forms a very picturesque object, and has frequently been engraven. Continuing our walk round the island, we ascended, to a certain height, that part of the rock up which lies the way to the castle, in order to observe the eastern coast of the bay, whence this island is at but little distance. Most of the cliffs on  
this

this side are the section of a very thick loose soil ; but beneath their foot appear masses of *schistus* in great disorder, and all the bed of the sea along these cliffs presents ledges of the *schistose* strata, descending under the water with an inclination towards the west. It is therefore evident, not only by the subsidence of a part of the mass of *granite*, the remaining part of which forms *St. Michael's mount*, but by the inclination of the *schistose strata* descending towards the middle of the bay, that this *island* is a ruin of both these kinds of *strata*, left at a higher level than the other masses, during the vast *subsidence* by which has been produced the present bed of the sea, whereof *Mount's bay* is a part.

1209. At two o'clock, we reached the point whence we had set out, having completed the circuit of the island, which, by this time, was really such, as the water was now high ; the difference between the high and low tides being here, as I was told, eighteen feet ; so that we crossed in a boat the arm of the sea whereby this mount was separated from the coast. We had thus employed three hours in observations to which but little time had probably been devoted by Mr. Playfair. Mr. Vinicombe here quitted us to return to *Kenegie*, and I set out with Mr. Davies Giddy for his father's house at *Tredrea*. In the road, this gentleman pointed out to me, on the north of the peninsula, at some distance, the arm of the sea which bears the name of the *River Heyl*, because it is entered by that small stream, but which is properly

a gulph, penetrating nearly to the middle of the breadth of the peninsula ; and the soil that succeeds it in a direction towards the south is so low, that a canal might easily be cut along the hills which terminate at *Marazion*, and a communication thus opened between the *English* and the *Bristol Channels*, if sufficient advantage were expected from it ; which has not yet been the case.

1210. On arriving at *Tredrea*, I found there the elder Mr. Giddy, with his daughter Mrs. GUILLEMAR, who were so good as to take sufficient interest in my conversation with Mr. Davies Giddy, to permit me to continue it. I then mentioned to him that I particularly wished to observe, on the east of *Tredrea*, *Tregonning hill*, whence had been taken the granite which I had seen used at *Penzance* ; and to see on the west, the course of the river *Heyl*, flowing northward to the bay of *St. Ives* : he was so good as to offer to accompany me to the former place the next morning, and the elder Mr. Giddy proposed to take me down the course of the *Heyl* in the afternoon ; a plan very convenient to me, because I had appointed to meet Captain Vivian the day afterwards at the mine of *Dolcoath*.

*July 29th.* We set out at eight o'clock in the morning, in Mr. Davies Giddy's chaise, for the place whence the granite is taken, at the foot of *Tregonning hill*, which is about seven miles from *Tredrea*. We saw on the road a quantity of the stone



stone called *ekran* in this country, and some of the quarries where it was worked. This stone has a resemblance to *porphyry*, but is not the same which is *stratified* in mountains; and it was on this occasion that Mr. D. Giddy told me what I have already mentioned, that this *pseudo-porphyry* forms the material of some of the *cross-courses*, that it is not found in the country in any other situation, and that it is worked for building-stone: there are different kinds of it, one of which has nearly the appearance of *granite*, like that in the *cross-course* formerly worked for tin in *Wherry-mine*, near *Penzance*.

1211. Our road passed over some high ground, whence we had a view of the sea on the north and on the south, and whence the waters take their course from different points, along the *combes* which descend to the opposite coasts. It is quite impossible to suppose, with Mr. Playfair, that these channels can have been *excavated* by the brooks now flowing in them; the latter being formed in *combes* by the waters of the *springs*, which as I have often explained, there issue forth, because these cavities being the effect of *subsidence*, their sides consist of sections of the *strata*.

1212. *Tregonning hill*, which about six hundred feet in height, rises in the interval between the two seas; it is almost insulated, being separated from the nearest hill of the same ridge by a low space of considerable breadth: when we came to its foot, we

saw

saw the quarries on its slope at no great height, and on ascending to them, we observed the following circumstances: In one of the quarries, where there were men at work, we saw uncovered two very distinct *strata*, whence, by the assistance of their fissures, were extracted masses like those which I had seen at *Penzance*. These *strata* appear under a soil composed of rubbish; they are very much shattered; and the workmen told us, that, when they are followed, they are found to terminate, either laterally, or some way within the hill, as they are only insulated *masses* buried in the *rubbish*; in some other excavations, where similar masses had been taken up, we saw nothing but *rubbish* in the place where they had lain. A well had been dug on the slope, where the water was about fifteen feet below the surface; and we saw that its sides were the section of a mass of these *strata*, which probably extended farther into the hill.

1213. It is very evident that no cause in action on the continent since it has existed can have either *insulated* this hill, or enclosed within it *masses* of *strata* under rubbish; and it is here impossible not to perceive, that these are effects of the *catastrophes* which formed the *hills* themselves by a greater *subsidence* of the parts around them, and that the fractures and trituration of the separated masses, during their angular movements, are the only possible cause to which this chaos of insulated masses buried in rubbish can be attributed. I have already described a  
similar

similar phenomenon, though accompanied with less disorder, in the hill near *St. Columb*, which likewise belongs to the *strata* of *granite*; and it is of the same kind with those before mentioned, as well in the *strata* of *schistus* on the hill of *Roscarrock*, as in the *calcareous strata* of *Offwell* and *Wedworthy* in *Deconshire*.

1214. There is a signal-post at the top of this hill, towards which we ascended: in some parts the turf is taken off for fuel, and the remains of the vegetable earth being washed away by the rains from the spaces thus uncovered, the soil is there seen to be composed entirely of granitic rubbish; and the surface is every where scattered with blocks which appear above the grass, as well as with smaller masses. Now our observations on the preceding day having engaged our attention to the state of the *granite*, we found, and with much more variety, the same *veins* in these masses on *Tregonning hill*, as in the *granite* of *St. Michael's mount*; and they were observable even in fragments so small, that I was able to bring them away with me as specimens. One of these pieces, of which the two outer sides are of *granite*, has a *vein* of *pseudo-granite*, an inch and half in thickness, with its *capel* of *quartz*; the *quartz* becomes greyish at its contact with the *pseudo-granite*, the latter containing no *mica*, though there is *mica* in the *granite* on the sides. In another mass, which has also *granite* on both sides, there is a *vein* of *quartz* an inch thick, grey at its contact with the *granite*, and becoming  
brownish

brownish towards the middle. A third mass, still with *granite* on both sides, contains a *vein* of *white quartz* confusedly crystallized. In a fourth mass, the *capels* of *quartz*, very distinct, have their surface covered with small crystals, against which, on each side, has been formed a stratum of quartz confusedly crystallized, these strata being separated by a reddish substance forming the middle of the *vein*. Lastly, in a fifth, where the *vein* is an inch and an half in breadth, similar strata of white quartz have advanced on both sides, but not having every where united in the middle, they are covered, in all the intervals, with small *crystals*. We saw large masses, containing wider *veins* of both kinds; but they had been broken in the division of the masses; and I saw also, on some fragments, remains of veins of *pseudo-granite* attached to one of the sides.

1215. When we reached the signal-post, which commands a great extent of country, we saw, on the western side, the eminences of *granite* bordering the coast as far as the *Land's-end*, but with many interruptions. At a small distance on the N. E. was *Mount Godolphin*, belonging to the same granitic chain; and on the S. E. the view extended over that great projection of the peninsula which is terminated on the south by *Lizard-point*. This is a very interesting part of the county, as well because of the gulphs that render the above projection nearly an island, as from the change in the nature of the *strata*, of which I had been informed; and on both these

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accounts

accounts I went to observe it some time afterwards.

1216. Having returned to *Tredrea* sufficiently early for our plan of proceeding the same day along the course of the river *Heyl*, we set out on this new excursion with the elder Mr. Giddy; and it will be seen whether this river can be supposed to have cut its own channel. At a little distance from *Tredrea*, these gentlemen pointed out to me a pool, into which this river enters, and which serves as a reservoir for times of drought, when the stream alone is not sufficient to turn a mill; in rainy seasons, or sudden thaws, its waters are in part allowed to pass off by their natural channel. This small river, though it retains its name the whole way to *St. Ives-bay* on the north of the peninsula, yet arrives at the level of the sea at *Trewinnard*, about three miles distant from the coast; for so far do the tides come up. As we descended towards that place, the tide was beginning to ebb; and on both sides of its course, which was also that of the little river, we saw large green marshes beginning to appear; these soils are raised by the sediments of the tides, with a progress sufficiently sensible to be observed by the inhabitants.

1217. At *St. Earth*, we crossed this æstuary by a bridge; and here Mr. Giddy told me, as a fact known by tradition, that the people, whose occupation it is to search for grains of tin ore in the *granitic sand* covering

covering the slopes of several hills, and the bottoms of some vales, had followed one of the latter, which joins the æstuary a little below the bridge; and after they had penetrated through this *sand*, brought down thither by the rains, instead of continuing to find the grains of ore on strata of *schistus*, as in the upper part, they found them on *sea-sand*; which consequently must have been deposited on the bottom of this branch of the æstuary, before the *granitic-sand* could have been spread over it by the rains. This is a remarkable fact, unexpectedly coinciding with those which I have already adduced as clearly proving, that neither the *rain-waters*, nor those of the *sea*, have cut the channels whereby the latter have, in many places, entered a great way into the lands; but that these channels existed at the birth of the continents.

1218. We followed the left bank of the river, or rather the western side of the ancient gulph into which it originally discharged itself, as far as *Lelant*, where this gulph opens into *St. Ives bay*; and here I observed a striking phenomenon, of which I had been already apprized by my obliging companions. The *sand* of the outer strand, raised up by the winds, produces in this part the same effects which I have described on the eastern coast of the gulph of *Padstow*; but this is a sand of a perfectly different nature, being of the kind already mentioned, which is composed of marine bodies, comminuted by the waves that violently dash them against the rocks on

the coast. From *Lelant*, I set out to walk down to the open sea ; and in my way I came to nothing but *dunes*, rising one on another, under which I was told that many houses had been buried, without any possible means of preventing it : and the case is the same along the coast on the east to a considerable distance ; an interesting object, to which I shall have occasion to return.

1219. Opposite to *Lelant*, the gulph is joined by a large æstuary, which follows to the eastward the direction of the coast, passing between *Phillack* on the north, and *Bodrigy* on the south. This æstuary being the lowest part of a large vale, it is entered at the higher end by a stream bearing the name of *Phillack*, the level of which is raised by a dam, that it may work the machines of a copper foundery. But, in order to profit by a situation so favourable for importation and exportation, it is necessary to keep open the passage to the sea, which the *sand* brought into the gulph by the waves and the tides is continually tending to obstruct ; and this effect, though it cannot be entirely prevented, has however been retarded in the following manner : At the opening of the æstuary has been raised a dike, with a wide sluice, which is left open while the tide is flowing, in order that the æstuary may be filled up with the sea water ; but when the tide has risen to its greatest height, this sluice is closed, and not opened again till the ebbs ; the violence of the current, which then carries down the sand before it, and

has hitherto preserved a channel for small  
als.

20. In returning from *Lelant*, Mr. Giddy led out to me, near *Tredrea*, the *adit* of some  
s, which shews of what materials are composed  
lopes of most of the hills in this country, now  
ed with grass. The water of this *adit* was  
ng externally along a space of considerable  
h; because, in order to save wood for props,  
called *stalling*, the *rubbish* which forms the  
of the hill had been cut through, as far as the  
se of throwing it up on the sides would permit;  
n advancing farther into the foot of the hill as  
tinued to rise, the thickness of the *rubbish* be-  
at last so great, that it was necessary here to  
a gallery, *stalling* it up to the point where it  
he extremity of another gallery, which set out  
the mines, and was bored through the mass of  
ata of *schistus*. Mr. Giddy told me that this  
be case at the issues of the *adits* in almost every  
of *Cornwall*; and I have seen the same thing in  
districts of mines on the continent; which  
rs with the situation of the *strata* within, as  
ered by the working of the mines, in shewing  
was the state of the *hills* at the time when the sea  
oned them, and retreated into its present bed.

21. On our return to *Tredrea*, we found there  
iddy of *Penzance*, who had brought a specimen  
ery singular *gangue* lately found at the depth  
of



of seventy fathom, in a *load* worked at *Relistian* in the parish of *Gwinear*. The *load* in that part becomes a *breccia*, composed of rounded fragments of a hard *kellas*, connected by a schistose substance; but between these masses remain vacancies, some of which are filled with greyish mundic, and others are lined with cubical pyrites, crystals of *quartz*, and crystallized tin ore. This *load*, though here very unproductive, was still continuing to be worked, in the hope that it would return to its original state. This is a very interesting symptom of what passed in the ancient sea, while its liquid contained many of the substances afterwards separated from it. There are abundant proofs, that, subsequently to the first catastrophes which produced the fissures wherein the *loads* were formed, and before the latter had been broken and subjected to angular movements, the strata underwent such concussions, as occasioned to fall, from the sides of the fissures, fragments, afterwards enclosed in the gangue which filled up those fissures; small masses of granite and of schistus (or *kellas*) being found in the parts where it passes through their respective strata. Now it farther appears in the *load* of *Relistian*, that the sea, by the agitation of its bed in the catastrophes which took place there, had rounded the fragments on the surface of the strata, in the same manner as is found in other *breccias*; and that here these rounded fragments fall into the fissures, during the process of the formation of their gangue. I should be tedious were I to enter into all the details of the facts concerning  
which

which I had opportunities of gaining information in this journey, when I was every where in the company of well informed persons; I have therefore been obliged to confine myself to the principal circumstances.

*July 30th.* This was the day which had been appointed for my meeting with Captain Vivian at *Dolcoath mine*, whence I was to proceed in the evening to *Pendarves*; and as the elder Mr. Giddy was to go this morning to *Camborne*, which is not far from the latter place, I set out with him at nine o'clock from *Tredrea*, and we travelled together a great part of the way.

1222. The low tract extending across the peninsula from *St. Ives bay* to *Mount's bay*, when viewed from the hills on its eastern border, over which we first passed, forms, with the opposite hills, one of the most cheerful parts of this county; not only from its rich cultivation, and hedges interspersed with trees, but from the *woods*, on the slopes of the western hills: I had these in view, when I spoke before of a method of favouring the growth of *woods* which had been for some years employed in *Cornwall*, and which I shall here explain; Mr. Giddy having confirmed to me what I had already heard respecting it from Mr. Thompson at *Penzance*, before I had seen the part of the country where this method originated. The winds, and particularly those from the west, which, having crossed a vast extent

extent of sea, pass over this projecting part of the peninsula without any impediment, used to destroy all the *trees* here; for though, in large plantations, the first row exposed to their action served for some time as a protection to those behind it, yet, as one row decayed after another, in the course of time the whole perished. The late MR. PRAED, of *Trevethoe* near *St. Ives*, having made plantations of many foreign trees, and among others of the *pinaster*, a pine which bears large cones, remarked not only that the latter resisted the effect of the winds, but that other trees flourished behind it. He then determined to make a large nursery of these pines; and when they were of a sufficient height, he undertook great plantations of various kinds of trees, guarding them on the western side with a double row of *pinasters*. This method perfectly succeeded, the other trees becoming large and vigorous; and the woods thus formed were those of which we had a view on the slope of the hills on the side next *St. Ives*. Mr. Praed's success has induced many other gentlemen to adopt the same plan; and in time, *Cornwall* is likely to become a woody county.

1223. In passing through the village of *Tapper*, we observed a small stream, which is there seen arriving from a distance with very little declivity; but it suddenly begins to flow rapidly, and is employed in turning the rollers of a forge for iron bars; thence, crossing the village, it rushes precipitately into a deep cleft, and thus arriving at the bottom of the

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the hill, it joins the river *Heyl* in its æstuary. This is a case too frequent in stony hills and mountains, to allow any attentive observer to entertain the idea that the *brooks* descending from eminences have cut their way to the principal *channel* in which flows the *river* formed by their union.

1224. From many parts of the road, we had a view of the heights bordering the sea, on the east of *St. Ives bay*; I remarked that among these were interspersed some whitish eminences, the nature of which I inquired of Mr. Giddy; and he told me, what Mr. Stackhouse afterwards confirmed with many details, that these small hills were composed of the *sand* which the winds raise from the sea-shore, and carry over the neighbouring country. This *sand* is continually gaining on the land, where it successively overwhelms inhabited places; and the accounts of its progress are transmitted from one generation to another. This then is a new *chronometer*, possessing the same conditions that I have already pointed out with regard to others; all these chronometers consisting in *effects* resulting from known *causes*, which can have acted only since the *continents* have existed, and of which the *progress*, within known *times*, is indicated by *monuments*. This phenomenon, both here and at *Padstow*, has so great a resemblance to that produced by the *sands* of *Lybia* on the borders of the *Nile*, that I am induced to copy what my brother has written respecting the latter, in a paper inserted

inserted in the *Mercure de France*, for September, 1807.

“ The *sands* of the *Lybian desert*,” he says, “ driven by the west winds, have left no lands capable of tillage on any parts of the western banks of the *Nile* not sheltered by mountains. The encroachment of these *sands* on soils which were formerly inhabited and cultivated is evidently seen. M. DENON informs us, in the account of his *Travels in Lower and Upper Egypt*, that summits of the *ruins* of ancient *cities* buried under these *sands* still appear externally; and that, but for a ridge of mountains called the *Lybian chain*, which borders the left bank of the *Nile*, and forms, in the parts where it rises, a barrier against the invasion of these *sands*, the shores of the river, on that side, would long since have ceased to be habitable. “ Nothing can be more melancholy,” says this traveller, “ than to walk over villages swallowed up by the sand of the desert, to trample under foot their roofs, to strike against the summits of their minarets, to reflect that yonder were cultivated fields, that there grew trees, that here were even the dwellings of men, and that all has vanished.”

“ If then our *continents* were as *ancient* as has been pretended, no traces of the habitation of men would appear on any part of the western bank of  
“ the

“ the *Nile*, which is exposed to this scourge of the  
 “ *sands* of the desert. The existence, therefore, of  
 “ such monuments attests the successive progress of  
 “ the encroachments of the sand ; and these parts of  
 “ the bank, formerly inhabited, will for ever remain  
 “ arid and waste. Thus the great population of  
 “ *Egypt*, announced by the vast and numerous ruins  
 “ of its cities, was in great part due to a cause of  
 “ fertility which no longer exists, and to which suf-  
 “ ficient attention has not been given. The *sands* of  
 “ the desert were formerly remote from *Egypt* ; the  
 “ *Oases*, or habitable spots still appearing in the  
 “ midst of the sands, being the remains of the soils  
 “ formerly extending the whole way to the *Nile* ;  
 “ but these *sands*, transported hither by the western  
 “ winds, have overwhelmed and buried this exten-  
 “ sive tract, and doomed to sterility a land which  
 “ was once remarkable for its fruitfulness.

“ It is therefore not solely to her revolutions and  
 “ changes of sovereigns that *Egypt* owes the loss of  
 “ her ancient splendour ; it is also to her having  
 “ been thus irrecoverably deprived of a tract of land,  
 “ by which, before the *sands* of the desert had  
 “ covered it and caused it to disappear, her wants  
 “ had been abundantly supplied. Now, if we fix  
 “ our attention on this fact, and reflect on the con-  
 “ sequences which would have attended it if thou-  
 “ sands, or only some hundreds of centuries had  
 “ elapsed since our continents first existed above the  
 “ level of the sea, does it not evidently appear that  
 “ all

“ all the country on the west of the *Nile* would  
 “ have been buried under this *sand* before the erec-  
 “ tion of the cities of ancient *Egypt*, how *remote*  
 “ soever that period may be supposed; and that, in  
 “ a country so long afflicted with sterility, no idea  
 “ would even have been formed of constructing such  
 “ vast and numerous edifices? When these cities  
 “ indeed were built, another cause concurred in  
 “ favouring their prosperity. The navigation of the  
 “ *Red sea* was not then attended with any danger  
 “ on the coasts: all its ports, now nearly blocked up  
 “ with *reefs* of *coral*, had a safe and easy access;  
 “ the vessels laden with merchandize and provisions  
 “ could enter them and depart without risk of being  
 “ wrecked on these shoals, which have risen since  
 “ that time, and are still increasing in extent.

“ The defects of the present government of *Egypt*,  
 “ and the discovery of the passage from *Europe* to  
 “ *India* round the cape of *Good Hope*, are therefore  
 “ not the only causes of the present state of decline  
 “ of this country. If the *sands* of the desert had  
 “ not invaded the bordering lands on the west, if the  
 “ work of the *sea polypi* in the *Red sea* had not ren-  
 “ dered dangerous the access to its coasts and to its  
 “ ports, and even filled up some of the latter, the  
 “ population of *Egypt* and the adjacent countries,  
 “ together with their product, would alone have  
 “ sufficed to maintain them in a state of prosperity  
 “ and abundance. But now, though the passage  
 “ to *India* by the cape of *Good Hope* should cease  
 “ to

“ to exist, though the political advantages which  
 “ *Egypt* enjoyed during the brilliant period of  
 “ *Thebes* and *Memphis* should be reestablished, she  
 “ could never again attain the same degree of  
 “ splendor.

“ Thus the *reefs* of *coral* which have been raised  
 “ in the *Red sea* on the east of *Egypt*, and the  
 “ *sands* of the desert which invade it on the west,  
 “ concur in attesting this truth : That our continents  
 “ are not of a more remote *antiquity* than has been  
 “ assigned to them by the sacred historian in the  
 “ book of *Genesis*, from the great era of the *Deluge*.”

1225. These are not the only proofs afforded by *Egypt* of the recent origin of our *continents* ; the *Delta*, formed at the mouth of the *Nile* by the sediments of that river, supplies us with another chronometer. According to the account of M. de Dolomieu, these sediments have here, (as I have shewn to be the case in the *marshes* of *Somersetshire*), encompassed *islands* consisting of *calcareous strata*. It is the same with all the *Deltas* which have been formed at the mouths of great rivers in every part of the world, and which are still continuing to extend themselves, with this common circumstance ; that these new soils are absolutely *horizontal*, and, when not enclosed with dikes, are still subject to inundations from the waters both of the land and of the sea : this is what I have already shewn in these travels, along the shores of the *Baltic* and of the  
 North



*North sea*, and around the coasts of *England*. In my first geological work, I had adduced this well-known circumstance as a direct proof, that, since our continents have existed, their relative *level* with the sea has never changed; and it ought to have prevented the hypothesis which, in the Huttonian Theory, has been indirectly opposed to what I had detailed in the above work, with regard to the different *maritime chronometers*; I mean, the hypothesis of alternate *elevations* and *subsidences* of some parts of the coasts, in times very *modern* comparatively with the origin of the continents themselves; for this hypothesis, to bear any appearance of probability, ought, since the same phenomena are every where observed, to comprehend all coasts around every part of the continents. I now return to the account of my journey.

1226. It was noon when Mr. Giddy and I arrived at *Dolcoath mines*. Captain Vivian had been so good as to prepare all that was necessary to give me an exact idea of the different *strata* through which the *loads* of this district pass, of the points where these loads are intersected by the *cross courses* formed in later fractures, and of the parts of the loads already worked, with their various accidents. He first shewed us the plans of the interior part of these mines, which had been drawn, and continued as the work advanced, with geometrical precision. But besides the general idea furnished by these plans, he had sketched, on separate sheets, for my farther  
infor-

information, some sections of the *loads* in the parts where they have undergone the greatest alterations from the *cross courses*; indicating the different *strata* intersected by both, and the changes of level produced in those strata, as well by the first *fractures* in which the *loads* were formed, as by that greater catastrophe in which the loads themselves were broken, and subjected to angular movements. Thus, being already sufficiently acquainted with the interior part of mines, I acquired more information respecting these in Captain Vivian's room, than I could have gained by descending into them with the best guide; for then I could only have seen those objects successively and obscurely; whereas here they were all brought before me in a distinct, though contracted view; and it is from this clear and accurate information that I shall now describe their most essential circumstances.

1227. In this district of *mines*, there is one principal *load* which is worked to an extent of two miles from east to west. This *load*, meeting the surface the whole way, has been attacked in several points, either by different proprietors of the ground, or by different companies of adventurers; whence have resulted many distinct *mines*. Beginning from the east, the names of these *mines*, over all which Captain Vivian presides, are *Wheal Druid*, *Wheal Fanny*, *Tin Craft*, *Cook's Kitchen*, *Dolcoath*, and *Cambom Wean*. This whole space has a very extraordinary and dreary aspect, and might be taken, when

when first approached, for a volcanic country, in which the eruptions were still continuing : but, when viewed from an elevated spot at some distance, it much resembles a piece of ground worked by miners of a very different nature, having the appearance of a thin pasturage interspersed with mole-hills ; for even the levers of the steam-engines, which put every thing in motion under ground, suggest the idea of the sticks of the traps usually set to catch those diminutive miners. The whole of what has been here effected by art, respecting which, as I walked over this space, Captain Vivian gave me distinct information, is truly admirable : indeed I know nothing, but a dockyard for men of war, that so fully manifests the resources of the human mind for the production of immense effects, though the natural strength of man is comparatively so small.

1228. As the *mines* belong to different companies, the interior limits of most of them are determined by vertical planes, corresponding with lines traced on the surface of the ground. But in some places, as for example, between *Cook's Kitchen* and *Dol-coath*, these mines have a natural limit, formed by a *cross course*. Here this *course* does not follow exactly the limit of the lands, but it has, by agreement, been made that of the *mines*, because it produces a division of the interior waters. In this part of the peninsula, on the east of the low grounds which divide it from north to south between *St. Ives bay* and *Mount's bay*, the nature of the *cross courses* does

s not vary so much as in the western part: most hem have on their western side a *capel* of a *clay*, enetrable by water: it is this part of them only ch forms the division of the interior waters; the of their mass being most frequently composed of ments of different stones imbedded in soft mate- . The *cross course* which separates *Cook's hen* from *Dolcoath* is in some parts 10 fathom in kness, and in others less than three: it *underlays*, nclines, three inches in a fathom, towards the ; but other *cross courses* have the same degree nclination towards the west, and some are ver- l.

229. The principal *load* of the mines of which I speaking is 20 feet thick in some parts, and not ve eight in others. Several *loads* parallel to this, less considerable, and at little distance from each ar, are worked at the same time in each mine; there is more variation in these than in the prin- d *load*. The *cross courses* are evidently posterior he *fissures* in which the *loads* have been formed, e they intersect them, and have occasioned nges in the level of the parts thus divided; how- r, in some places they have had great influence in mineralization of their *gangues*; of which a striking mple is found in comparing the two sides of the s *course* which separates *Dolcoath* from *Cook's hen*, and of which the line is marked on the sur- e by a glen. The same *loads* are worked in both e mines; yet the difference between the two sides

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divided by the glen is striking even to the sight. On the side of *Cook's kitchen*, the heaps of ore, the water of the stamps, and the miners themselves are all red while nothing of this kind appears on the *Dolcoal* side; and the following is the cause of the difference as explained to me by Captain Vivian. On the side of *Cook's kitchen*, the whole of the main *load* is penetrated with an *iron mineral*, which the water and the air decompose into *ochre*, even within the *load*, where all the crevices are lined with it. The solid pieces indeed are not of this colour when freshly broken, but their surface acquires it in the heaps; and from the redness of the dust produced by stamping, of the water which carries away that dust, and of all the people who work here, men, women, and children, I could have fancied myself among iron mines, where the veins consist of *hæmatites*.

1230. There are moreover differences between the *loads* themselves in this country; and first, though the *direction* of all is from east to west, they vary in their *inclination*, or *underlay*; some inclining towards the north, others toward the south; now here the former are richer than the latter in metallic product, while, in other districts, the contrary is observed. There are also changes in this respect, and even in the nature of the ore, in the same *load*, when it is met and intersected by another. In the above mines occur very remarkable examples of these alterations; one of which is as follows: some *loads*, inclining towards the south 15 inches in a fathom, had been  
worked

worked to the depth of 58 fathom, with a product little more than sufficient to pay the expense: at that point they were found to be intersected by a small *load*, with an equal inclination to the north, and for 10 fathom below this, they were very rich in grey and yellow copper ore; but still lower, they were again impoverished, and had continued in the latter state to the depth of 182 fathom, to which they had then been followed.

1231. Captain Vivian gave me the example of another case, by shewing me a drawing of the *section* of a part of these mines, where two *loads* also intersect each other by their opposite inclinations, and change their respective levels: one of these is called the *Great load*, and the other, much smaller, is named the *Toay load*; both are found at the surface, immediately under the loose soil; but they pass downwards through the whole mass of the *strata*. The *fissure* in which the *Great load* has been formed must have been posterior to that which contains the *Toay load*; having considerably changed the level of its divided parts; these loads meet at the depth of 106 fathom, whence the *Great load* continues its course: at this point, the section of the two *loads* may be represented by a capital italic *Y*. Lower down, the *Toay load* is again found, but on the opposite side of the great one; so that, at this second point, the section may be represented by the same capital reversed, *A*; and the former of these letters, placed over the latter, would exhibit the figure

figure of the whole section. Now neither of these two *loads*, down to their point of junction, where the *Toay load* has sunk, furnishes any *ore* but of *copper*; while below this point, scarcely any thing but *tin ore* is contained, first in the *Great load* alone, then in the *Toay load* also, when it re-appears with less inclination. All these cases are evidently contrary to the idea that the *gangue* of the *veins* consists of materials which had been *melted* and injected into the fissures from beneath the strata; nor can they be referred but to the system of a successive formation, by *precipitations*, in the bosom of the *primordial liquid*, while it still contained the multitude of *elements* of which all known terrestrial bodies have been composed.

1232. Captain Vivian had been so good as to prepare another very interesting drawing, representing a horizontal section of the district of *Cook's kitchen* and *Dolcoath*, with all the *loads* on both sides of the *cross course*, and the quantity of change produced by the latter in the level of the former; together with the dislocations which the *loads* had undergone in meeting each other. But these details are not necessary, nor could they be described without a reference to the drawing; I shall therefore proceed to a more essential point, concerning the *granite*. In our first conversation, I had spoken to him of the Huttonian hypothesis, with which he was already acquainted; and he had then said, that if Mr. Playfair, in his journey through *Cornwall*, had consulted

the miners, he would have met with none who would not have told him that the *granite* could not possibly have been in *fusion*; since the *fractures* wherein the *loads* have been formed pass into it directly from the *kellas*. In order to give me an example of this fact, he had now chosen a mine into which he had himself accompanied a zealous partizan of the Huttonian theory, (whom he named to me; and) who, after having seen what I am going to describe, quitted the mine, convinced, not only that the *granite* could not have been in *fusion* when the *strata* underwent their first *fractures*, but that neither the *growan*, nor the *sand* of the same kind so abundantly spread over a great part of this county, could be considered as *decomposed granite*.

1239. The drawing which Capain Vivian gave me relative to this object represents a vertical section of the *load*, in the part where the *shaft*, in which the pumps are worked, and the ore is brought up, has been sunk through it to as great a depth as possible, in order to facilitate the motion of the pump-rods; and at a point where the *load* suddenly assumes a great inclination, in consequence of a *cross course*, a beam has been placed, in order to change the direction of the rods. I shall now enumerate the *strata* through which this *load* passes, beginning from the surface; their thickness being determined on an average of the variations observed in different parts, according to the direction of the *load*. The first 15 fathom are in superficial *gowan*; the 20 fathom



the *liquid* originally covering the whole globe; and that it was followed by the successive precipitations of all the other kinds of *strata*. I have explained this system in my *Elementary Treatise of Geology*, and traced its physical consequences, which I have shewn to be in constant agreement with precise *monuments*, from that *first* determined *epoch* to the *present state* of the earth.

1236. After this interesting visit to the mines of *Dolcoath*, Mr. Giddy and I set out from thence; and having proceeded some way together, we parted at the gate of Mr. Stackhouse's park. I had much pleasure in returning to this estimable and amiable family, and in communicating to the elder Mr. Stackhouse the remarks suggested to me by my own observations, and by the information that I had received from others, since I had quitted his house; remarks, which he confirmed, by many correspondent facts. Here, moreover, the plan of my future journey was determined by two circumstances. Mr. E. Stackhouse having been at the county assizes at *Bodmin*, had met there Captain Penrose; who, on hearing that I should soon return to *Pendarves*, had sent me by him the invitation already mentioned, of which I afterwards availed myself. But besides this, I found at *Pendarves* Mr. PEARCE ROGERS, who resides at *Helstone*, a place situated between the rivers *Hel* and *Loe*, which, as they rise near each other, while the former discharges itself on the east, and the latter on the west, almost entirely insulate the  
great

great projection terminating in *Lizard point*, a part of *Cornwall* which it had previously been my intention to observe. Mr. Rogers being so good as to offer me his assistance in this excursion, I accepted it with great pleasure; however, we did not set out together, because he was to return directly to *Helstone*, and Mr. Stackhouse thought that, before I went thither, I ought to go to see an original gulph at the extremity of the river *Loe*, which has been changed into a *lake of fresh water*; and he was so good as to give me a letter to Mr. JOHN ROGERS, in whose estate, called *Penrose*, this lake is situated. Lastly, it being my farther design, before I quitted *Cornwall*, to return to *Killiw*, in order to take leave of my first director, Mr. Gwatkin, Mr. Stackhouse was so good as to make a new itinerary for me, day by day, which enabled me to fix the time of my arrival at *Killiw*, by *Penryn*, after I should have completed the tour of the western part of the peninsula; and I then wrote to inform Mr. Gwatkin of the day when I expected to be with him.

*July 31st.* I set out in the morning from *Pendarves*, for *Penrose* and *Helstone*. The first part of the road lay along the eastern foot of the two granitic eminences, *Tregonning hill* and *Godolphin hill*: in following these, it evidently appears that they are *eminences* only because the *strata* have *subsided* around them. When I came to the border of this high ground, I had before me a beautiful prospect of the lower country, its various inflexions being embel-

embellished by culture; and I saw the town of *Helstone* rising beyond a large basin, surrounded with small hills, the eastern slopes of which discharge their waters into the river *Hel* and its gulph, the northern into one of the branches of the gulph of *Falmouth*, and the southern into the *Loe*. At the beginning of the descent from the high ground, which is very rapid, I perceived that the *strata*, here of *schistus*, descend towards the basin, following the slope. Lower down, I saw that the sides of this basin are intersected with combes, the river *Loe* being formed by the waters of the latter; and I began to observe on the slope a quantity of fragments and large masses of *white quartz*, which I afterwards found scattered on all the grounds bordering the *Loe* on the eastern side.

1237. When I was about half way down the hill, I quitted the high road, and turned into a lane on the right, which brought me nearer the coast. Ascending here a ridge of hills, I had, from their top, the view of a great part of *Loe pool*; and on thus looking down upon it from an elevated spot, I could clearly perceive, what every circumstance afterwards confirmed, that this *lake* had originally formed a part of a long *gulph* between hills, receiving no other land-waters than those which flow down to it from combes within an extent of about six miles. Descending hence, I came into a beautiful combe planted with trees, belonging to the park of *Penrose*; and following this, I entered meadows which border the ancient  
*gulph,*

gulph, now bearing the name of *Loe pool*. I proceeded through these meadows, in a direction towards the sea, till I arrived at the bottom of a lawn ascending towards the house; there I saw some young ladies seated on a bench, and alighting from my chaise, I went up to them; one of them rose to meet me; and on my inquiring for Mr. Rogers, she told me that her father was not at home, and would not return till the next day; on which I delivered to her Mr. Stackhouse's letter, begging that she would open it. After having read the letter, she very obligingly expressed much regret at her father's absence, and invited me to stay at *Penrose* till his return; but I told her that my time was fixed by appointments on the road; and I asked the favour that she would send a servant to shew me the way to the sea-side: however, two young brothers of hers, who were present, desired to be my guides, and I accepted their offer with pleasure.

1238. Few walks can be more agreeable than that by which I now proceeded to the sea. The path, lying but little above the lake, winds through a wood round the foot of the hills, and the openings between the trees afford a great variety of views. This path, the parts where it crosses combes, some of them very rapid, has been cut in the *salisti*, the *strata* of which chiefly descend towards the sea; but I saw their inclination change in some ridges of hills separating the combes. As we approached the sea, I observed, on the opposite side of the gulph, a phenomenon similar to

to that already described at the entrance of the gulph of *Falmouth*; namely a vale (or long *combe*), which rises in a direction parallel to the coast, and in which I was told by my young guides, who were very intelligent, that no stream flowed but a brook: it was from them also that I first learned the circumstances concerning *Loe pool*, which I shall here relate, with the addition of some farther particulars afterwards explained to me by Mr. Pearce Rogers.

1239. It is known by tradition that *Helstone*, situated at the head of this gulph, was, in ancient times a sea-port, to which vessels came up with the tide, by a channel maintained through the sediments of the sea and land-waters. But a bar of gravel being gradually formed at the entrance of this gulph, as I have shewn to have been the case in many others already described, while this bar was rising and widening, the sediments of the waters accumulated at the head of the gulph, and the vessels found so much difficulty in coming up to the port, that, by degrees, its commerce was transferred to other places in the neighbourhood; and *Helstone*, being then no longer able to support the increasing expense of keeping open the channel, the bar at last completely closed the entrance of the gulph, which has since been changed into a lake of fresh water, like *Slapton lee*, in *Start bay*.

1240. Approaching the sea, I descended on the bar of gravel, which is so wide and so high, that I could easily believe what was told me by my young guides,

guides, that it cannot be passed over by the waves of the highest tides, even during storms, unless attended with a very rare combination of circumstances. The waters of the small river *Loe*, and of the brooks flowing through the combes which terminate in that inner space, filtrate through the gravel of the bar, and thus prevent the sea-waters from entering the same narrow passages, except so much as to impede the running off of the land-waters during the high tides; in consequence of which the common level of the water in the lake is at the mean height of that of the sea. *Loe pool* is stocked with fresh-water fish, trout, perch, carp, tench, and eels; but, as is also the case in *Slapton lee*, when the waves pass over the bar, they throw into the space within, a few flat fishes, which live and breed there.

1241. The bar is so wide, that, during seasons of long rains and thaws, the fresh-water running off too slowly through the gravel, the level of the lake sometimes rises ten feet higher. This produces a singular effect; which is that of stopping two mills, one on the *Loe*, the other on a lateral stream, their wheels being then partly in the water. If there is such a quantity of snow on the ground, as to render it probable that things will long continue in this state, a channel is then cut in the bar of gravel, in order to lower the level of the lake: this, however, cannot be done without paying an homage to the lord of the manor, the nature of which marks the period when the bar was entirely closed, for it consists of three  
halfpence

halfpence in a leathern purse. I saw the place of this channel near the hill on the west of the entrance of the gulph; but it was closed, as a very little time is required for the waves to fill it up.

1242. Having made these observations with my young guides, I returned with them to the house, where Miss ROGERS had had the kindness to provide refreshments: she was afterwards so good as to walk down with me to the border of the lake, in order to shew my driver the carriage road to *Helstone*; and I then took my leave of her, very grateful for her obliging hospitality. This road, which follows the bottom of the valley, is very agreeable, passing all the way through meadows bordered with woody hills, producing, by their widenings and contractions, a continual change of prospect. The river has preserved its course through the new grounds formed by its own sediments: it was at this time very low, so that I was able to see the section of the soil on its sides, gradually deeper as I went farther from the lake, it having been in this upper part that the sediments were soonest raised to the level of the inundations. The river was then flowing there five feet below the surface; and in the part of the section above its level, nothing appeared except sand and earthy particles; but I saw excavations in the meadows where, the sand having been cleared away, gravel was taken up from beneath it; I have shewn this to be the case in all the new soils which I have described as produced on any parts of the courses of rivers.

1243. On my arrival at *Helstone*, I called on Mr. Pearce Rogers, who gave me an immediate proof of his disposition to oblige me, by offering to employ the remainder of the day in accompanying me over the hills on the eastern side of *Loe pool*. When we had reached the most elevated point of these hills, I saw that there was a great difference in height between the two sides of the ancient gulph, the hills on the western side being much more lofty, and rising more rapidly, than those on the side where we stood, the slopes of which shew the section of the *schistose strata*, broken off towards the gulph. This side belongs also to the *Penrose* estate; and Mr. J. Rogers had some time since made plantations of *pinasters* on these slopes, which had succeeded very well; the part where we descended was already covered with large trees of this kind, and all the other parts that had been planted from year to year appeared equally to flourish. We went on towards the sea till we came to the combe already mentioned, which terminates at the lake near the bar. The lower part of this combe is covered with meadows, like the soil at head of the lake; we afterwards ascended it, and found it extend up to the high ground.

1244. It is not long since the upper part of these hills formed only a down; but agriculture has here made a great progress, which will furnish a new example of what I have before remarked, with respect to the tillage of lands hitherto uncultivated. Mr. Rogers leases out these lands for three lives, at half-



half-a crown an acre, on condition that they shall be cleared and kept in cultivation. For this purpose, it is necessary to remove from the surface a great quantity of masses of quartz, which would stop the plough; and hence it is manifest that this ground, covered with turf on the vegetable soil, produced by its own decays, has never before been tilled. The turf, being first taken off, is laid up in heaps, in order to be spread over the surface, after the stones have been cleared away; the large masses, some of which are above three feet in diameter, are employed in forming the enclosures, and the rest in gravelling the roads, here particularly necessary; for under these stones (which shew what strange catastrophes the inferior *strata* have undergone) the soil consists of clay. On these lands, the rapid steps of agriculture were visibly marked; some fields being already covered with fine corn, others newly cleared and enclosed, while in many the turf was only beginning to be taken off.

1245. After this excursion, we returned to *Helstone*, and arrived there at 8 o'clock. I spent the evening with Mr. Pearce Rogers and his family, and we arranged a plan for the following day; in the afternoon of which he had an engagement at *Helstone*, and I meant to proceed to *Menacan*, near the gulph of the river *Hel*; but he wished to accompany me in the morning to a place on the southern coast, at the distance of 10 miles, which is not far from the *Lizard point*, and is named *Kinance cove*, from the neighbour-

neighbouring village of *Kinance*. This place in itself is a very interesting object of observation, as is the whole of that part of the coast; but besides, considering what the state of the tide would be when we should arrive there, together with the direction of the wind, which was southerly, Mr. Rogers hoped that we should have an opportunity of seeing a very surprising phenomenon, peculiar to that spot.

*Aug. 1st.* We set out from *Hclstone* at eight in the morning, Mr. Rogers on horseback, and I in my chaise. For some way, I saw on the N. W. beyond *Loe pool*, the granitic eminences of *Tregonning* and *Godolphin hills*; the ground below them sloping down to the vale where the small river *Loe* is formed, consists, as has been seen, in strata of *schistus*, which must have undergone very great catastrophes, since their surface is covered with masses of *quartz* in such abundance. We travelled for some time over soils, the base of which was still *schistus*; but as, continuing to proceed southwards, we passed *Bochim* and *Bouithon*, though I had not perceived any great inflexion of the surface, I saw a change in the appearance of the soil: the masses scattered on it no longer consisted of *white quartz*, but of a stone the nature of which I could not at first distinguish. These masses were lying on a grey argillaceous soil, impenetrable to water; so that, when the land is cleared for tillage, which is going on here with the same activity as in all the other parts of this county, besides the ditches dug around

the newly enclosed lands, for the purpose of carrying off the rain-water, it has been necessary, at certain distances, to cut deep trenches, to receive the water from the ditches, and lead it into the nearest combs. In order to convert this clay into an arable soil, it must be mixed with sand, brought from those parts of the southern coast whence the carts can the most easily ascend: I saw heaps of the latter which contained abundance of small shells, but the sand itself was merely that of the sea. All the horses of the neighbourhood being employed in the carriage of this sand, and other agricultural labours, there had been yet no time to gravel the roads; which were consequently in such a state from the frequent showers, that I had much difficulty to pass along them in my chaise.

1246. Continuing our way southwards, we came into a space interspersed with small eminences, which are the points of rocks of the same colour with the stones scattered on the surface; and a heavy shower coming on, and washing these rocks, as well as the *blocks* and gravels which I had for some time observed, I saw that they all consisted of a very beautiful *serpentine*. These mounts, for the most part pyramidal, are composed of very distinct *strata*, shewing their section at the summit, and dipping under the soil, with various degrees of inclination and different directions, in different mounts. It is thus seen that, the whole mass of these *strata* having subsided with many fractures, the separated pieces have  
under-

undergone angular movements, inclining towards the points of the greatest subsidence; and that these catastrophes must have been produced beneath the waters of the sea, because, in this peninsula, no cause in action since the continents have existed can have either covered with clay these ruins of strata, or scattered on its surface the *blocks* and gravel of *serpentine*, substituted at the same level, and at little distance, for those of *quartz*, which lie on the soils where the basis is of *schistus*.

1247. *Kinance cove*, whither we were going, is on the west of the *Lizard point*, in the lower part of a *combe*, which descends from a great distance towards the sea, and in which flows a rivulet, formed by the springs issuing through the bordering sections of the strata. On approaching the brow of the hill above this *combe*, at some distance from the sea, I was much struck by the appearance of its abrupt sides, with large projecting rocks, especially the side opposite to that from which we viewed it; and Mr. Rogers having told me that it terminated in *Kinance cove*, I proposed that we should walk down into the *combe*, and follow it to the sea, leaving our horses under the care of the driver of my chaise; Mr. Rogers consented to this; and as we were to return by a different road, he described to the driver the place whither he was to go to wait for us.

1248. We found some difficulty in descending into the *combe*, among the blocks of *serpentine*, and

around the projecting rocks of the same stone. When we came to the bottom, we saw there nothing but heaps of blocks, under which we heard the murmuring of the small stream; in some parts, where it appeared, we could easily step over it, notwithstanding there had been very heavy showers that morning. On reaching the lower part of the *combe*, where its breadth is much contracted by the rocks bordering the coast, I was astonished at the spectacle which suddenly presented itself to my view. Many great obelisks, like *St. Michael's mount*, here rise in the sea; and having been washed by the late rain, the *serpentine*, of which they are entirely composed, and which is variegated with large spots of red, green, and black, displayed those colours with a brilliancy kept up by successive showers.

1249. We arrived here at low water, as Mr. Rogers had expected; which gave me an opportunity of observing that the actions of the sea, far from having detached these masses from the coast, are tending to unite them to it, by accumulating sand and gravel in the intervals, wherever the water is not too deep. These new grounds, being uncovered all the way from the coast to the foot of two of the above obelisks, afforded us access to them; and we ascended the nearest to a certain height. From this elevated point, we had before us the cliffs of the coast, which, at the opening of the *combe* just mentioned, is irregularly intersected, and has various recesses similar to *Lärderum torr* near *Ottermouth*, (§ 762;) but the features

features of *Kinance cove* are on a larger scale, and the colours more beautiful. I never saw *serpentine* so fine as this, either in the *Alps* or in the *Apennines*; but it has the same character to the touch; namely, that, though it is very hard, yet, in passing the finger over it with the eyes shut, it might be taken for soap. This is the case also with the *steatites*, of which there are here many veins in the *serpentine*, and some so wide, that this substance is taken out of the rocks, to be used, in some manufactures, in the composition of china: hence the part of the coast where it is chiefly found is indicated in the maps by the name of the *Soapey rock*.

1250. Mr. Rogers, wishing to surprise me, had not described to me the phenomenon, which the state of the tide and the wind (then very high) had led him to expect: these circumstances are necessary for its production; for Mr. Rogers afterwards told me that he had often brought travellers hither to see it who had been disappointed. Having gone round the obelisk at the same height to which we had at first ascended, we came to the brink of a deep chasm descending to its base; there I suddenly heard a great subterranean rumbling; and before I had time to ask Mr. Rogers what it was, an immense spout of water rose through an opening at the bottom of the chasm, and sprinkled us all over, notwithstanding the height at which we stood; but being already completely wet from the rain, though I was a little startled at this unexpected shower, I could not help laughing, in the midst of my astonishment,

ment. The opening which produces this phenomenon, the most surprising that I have ever seen on any coast, is called the *Devil's bellows*. We changed our situation, in order to see several repetitions of this water-spout, without being again exposed to its effects. The noise which precedes this kind of explosion is like the rolling of thunder; and near the chasm, the spout is accompanied with a hissing sound, extremely grating to the ears.

1251. Mr. Rogers afterwards led me to a place where some idea might be formed of the cause of this astonishing effect. I there saw a space where the sea, being very deep, encompasses the obelisk on the N.W. up to a ledge of rocks dipping vertically into the water, and thus terminating a kind of cove. This ledge, which unites the foot of the obelisk to the coast, and was then in part uncovered, inclines towards the opposite side, and has occasioned the accumulation of gravel and sand, whereby the obelisk is rendered accessible at low water. We advanced to the edge of this ledge, whence we saw that the waves, then very high, after having gone round the obelisk, dashed against these rocks. The above chasm or deep cut in the obelisk extends a considerable way below the level of the sea; so that, several times following when a wave arrived, we saw only a stream of water gush out from the same opening at the bottom of the chasm whence the spout is occasionally produced and cease to flow as the wave sunk; but after some repetitions of this simple effect, the rumbling noise

was again heard within, and was followed by the action of the *Devil's bellows*.

1252. As the tide was now rising, the opening on which we had long fixed our attention was at last covered by the water; when Mr. Rogers perceived this, he told me to observe what was about to happen. At a considerable height above, where I saw an oval orifice, about a foot in its widest diameter. After a certain time, the same noise was again heard within; a spout of water issued from this hole with still greater impetuosity than before from the lower opening; and all the space above the cove was filled with a thick mist, formed by the scattered spray; so that the smoke which accompanies a discharge of artillery seeming now to be added to the noise, I was almost surprised that I did not also perceive the smell of gunpowder, at the moment when I was involved in this apparent smoke, which was, however, soon dissipated. This, in a word, taken altogether, was one of the most astonishing sights that I remember ever to have seen; but it was entirely at an end as soon as the tide had risen to a certain height.

1253. On combining all the circumstances, the following appear to be the causes of these phenomena. From the ruinous external aspect of the obelisk, the *strata* of which have undergone great angular movements, it may be supposed that a succession of *caverns*, similar to those of the *Mendip hills*, and of so many other mountains, have been formed within it.



it. The waves probably rush in through some opening at the foot of the obelisk, and the air, disengaged from them by their dashing against the rocks within, strongly compresses that which is contained in the *caverns* themselves. The quantity of air thus separated from water is so great, that, in the *Alps* and the *Pyrennees*, very powerful bellows are made for forges, by the fall of a column of water, through a wooden pipe, into a closed cask, in which it dashes on a stone at the bottom; and the air disengaged from it is carried by another pipe, placed in the cover of the cask, into the foundery, where it has as great effects in the high smelting furnaces, as I have seen produced in other places by the largest bellows of the common kind.

1254. This then, in a general point of view, is probably the cause of the *Devil's bellows*. The waves from the open sea undoubtedly introduce themselves into these *caverns* by some sub-marine passage, and being broken against their pillars, the air thus disengaged compresses, as I have said, that which was already confined here: but this operation, though it prepares the phenomenon, is not sufficient to produce it; for the compressed air may escape through some other passage; and it is when this happens that the waves, which enter the caverns from the side next the cove, flow freely forth by the opening of the bellows: but if waves enter, at the same moment, through fissures on both sides of the foot of the obelisk, and act, in some point, like a piston, against

is enclosed and the disengaged air, that air forced to pass, with a great noise, from caverns, and these violent explosions of air and fire produced at the openings above mentioned, we regretted, that the very agitation of the sea, necessary for the production of this phenomenon renders it impossible to go round the obelisk, during the continuance of the operation; what passes there cannot be observed.

Though this phenomenon is the most striking instance in *Kinance cove*, the place is not interesting with respect to geological objects. which we had employed in the foregoing observations had rendered inaccessible to us the other the water having risen so high as to cover the edges of rocks forming a sub-marine connection between them. However, by changing our position on the coast, we obtained a view of all those obelisks, especially the most distant, which is the tallest and highest, and which, by its form, by the brightness of its colours after the rain, and some of its crannies covered with verdure, was an object more beautiful than surprising. Before the water rose sufficiently to prevent our proceeding along the base of the cliffs, we had been able to enter some of the caverns, the bottom of which we found, like a bar, covered with gravel; a proof that they have not been excavated by the sea. This cavern, which was sheltered from the rain, was only of the

the same greyish colour as that which I had at first observed on the hill, the surface of each fragment having been triturated against the rest; but where it had been wetted by the recent showers, the water, producing the effect of a varnish, made it display all the most brilliant colours of the *serpentine*.

1256. At the first sight of *Kinance cove*, of its cliffs with their grottoes, and the obelisks of the same stone which rise in the water in their front, those who suppose that the sea, by its continual actions, demolishes the continents, would undoubtedly imagine that, *in the course of time*, cutting through the *strata of serpentine*, it has separated from the coast and from each other these mounts, which it is constantly diminishing; and that continuing to attack the coast itself, and demolishing the *cliffs*, it has hollowed out these *grottoes* in them; but in this very spot we found one of the proofs already adduced that no such operations really take place. While the tide was out, we saw along the foot of the cliffs, around the mounts and the pillars of the grottoes, and on all the rocks dispersed in the sea near the shore, up to the high-water mark, a zone of the colour of rusty iron, formed by an uninterrupted crust of *barnacles* with a few *limpets*, which even lined the whole mouth of the *Devil's bellows*. How can it be believed that the sea *wears away* the rocks, when it is thus seen to be incapable of dislodging these small parasites? Against stony coasts, the waves *rise* without friction; and it is only the quantity of air disengaged in their falling back

on themselves which produces their rumbling  
 along the shores.

1257. Mr. Rogers's complaisance had, without his receiving it, detained him beyond the time at which he had intended to return to *Helstone*; so that he was obliged to leave me as soon as we reached the place where we had appointed my driver to meet us; but he rendered me a farther service before we parted. I was to go on to *Menacan*, at the distance of about eight miles, where I was that day expected by Mr. POLWHELE, rector of the parish, in consequence of a letter which Mr. Gwatkin had written to him: my driver would have been much at a loss to find the way thither, as many roads intersect each other in the upper part of the hills; but Mr. Rogers gave me directions, pointing out to him at a distance the steeples, by which we were to be guided.

1258. I found this road very interesting with respect to geological objects; but I must mention by the way a circumstance of a different kind: I saw several large tufts of the beautiful *Erica didyma*, which is peculiar to this part of *Cornwall*, and which I do not recollect to have seen any where else. The road passed near the top of several combes, extending down to the coast, on the east of the *Lizard Point*; and it is totally impossible to suppose them to have been hollowed out by the waters, as they do not afford a passage to any streams but mere rills formed by the springs on their sides. So long as I  
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proceeded on the soil of which the basis is *serpentine*, I saw rising above its surface ridges of rocks, consisting of *strata* of that kind, dipping inwards; then, for a considerable way, I perceived no traces of any *stony strata*; and when afterwards some appeared, they were of *schistus*. I was now going towards the *gulph* which, being entered by the small river *Hel*, is considered by Mr. Playfair as the *mouth* of that river, and is included by him among those particularly named in p. 369, where he adds: "it will appear perfectly clear, that they have been produced by their respective *streams*." I had therefore determined to see this river also; and I could not have obtained better information than from Mr. Polwhele, whose *History of Devonshire* had in many places been my guide, and who had recently published a similar work concerning *Cornwall*.

1259. It was half-past four when I arrived at *Menacan*, where Mr. Polwhele gave me a very obliging reception: on hearing that it was my intention to observe the arm of the sea into which the river *Hel* discharges itself, he told me that he regretted being obliged to set out the next day for *Truroe*; but as it was my intention to proceed from *Menacan* to *Penryn*, he proposed that we should travel together as far as *Gweek*, a place six miles distant from the sea, where the *Hel* enters its *æstuary*, so that it would be sufficient for that evening if I observed the entrance of the gulph, whither he was willing to accompany me immediately, notwithstanding

notwithstanding the frequent showers which were still continuing.

1260. *Menacan* stands on a promontory, terminated by a cape called *Little St. Dennis*, and separating two *gulphs*, one very large to the north, the head of which is entered by the *Hel*, and the other smaller, entered by the little river *Durra*. Going first over the promontory towards the latter, we came to the northern side of a very deep *combe*, of which we evidently saw that the lower part had been originally occupied by the sea, though it is now almost entirely filled up. We then returned back across the promontory, and proceeded to its opposite side, commanding the gulph of the *Hel*; and while we were looking down on this space Mr. Polwhele, being acquainted with what Mr. Playfair had said of it, told me that this *gulph* alone, if he had seen it, ought to have sufficed to make him abandon his system. It is known by tradition, that vessels formerly ascended to the head of the *gulph*, six miles above its entrance; while at present the prolonged course of the river cannot, at low water, be approached on foot at *Helford*, which we saw below us, only three miles from the sea, the bottom consisting entirely of soft mire; so that those who cross the gulph in that part are obliged to wait for high water, that the passage-boat may come up to the solid bank. At this point opens a large lateral *æstuary*, which extends a considerable way northwards, winding around the hills; several other *æstuaries*,

1262. I inquired at *Gweek* how far it was from that place to *Penryn*, and they told me seven miles; but I had reason to suppose this to be only the computation of horse or foot travellers; for we were nearly three hours on the road, which was extremely rugged, passing over ground filled with masses of *granite*, where we could advance but slowly, from the fear of breaking the carriage. For some way, the sides of the road shewed only a soil composed of rubbish of all kinds of stones, and amongst the rest, white quartz; then we ascended a hill covered with *blocks* and other fragments of *granite*, on a soil of that *granitic sand*, or loose *growan*, of which I have so often spoken, and shall soon speak more particularly. The elevated part of this ridge of hills is of great extent and is intersected with combes, some of them very deep, at the bottom of which are brooks flowing among *blocks* of *granite*. The quantity of these *blocks* scattered over the whole hill is very striking, some of them being of such a size as to appear from a little distance like cottages; they contain large crystals of feld-spar; and I saw men at work in breaking them for kirb-stones for the foot-pavements of streets. As we descended the hill towards *Penryn*, we came on a part of the slope where excavations had been made in the soil of *granitic sand*, in order to take out *white clay* for bricks, the strata of which lie under that sand: on coming down to a lower level, I again saw the *schistose* strata forming the base of the hill. I reached *Penryn* at about eight o'clock, and went immediately to call on  
Mr.

**gulph.** At *Gweek* I saw a promontory terminating a ridge of hills, from one side of which the *Hel* arrives, and from the other, a brook that joins it; but these, when united, form only a small stream, though flowing in a very wide space. We were told by people on the spot, that, at the spring tides, the water rises up to this point; that, when it ebbs, it leaves uncovered a space of seven miles in length, extending on the outer side of the gulph, and consisting entirely of mud, through which the little river preserves its course; and that this ground is still continuing to be raised by the sediments of the river and of the tides. Thus it cannot certainly have been by the actions of these waters that an arm of the sea has here been formed between hills.

1261. It was at this place that Mr. Polwhele and I were to part; as he was going to *Truroe*, and I to *Penryn*, which is situated at the head of the æstuary descending to *Falmouth*; but we were to meet again the next day at *Killiw*. I now had to cross a ridge of hills, which separates the gulph of the *Hel* from that of the *Fal*. It has been seen that the hills on the southern side of the former river and its gulph consist simply of *strata* of *schistus*, covered with a very thick *argillaceous* soil: and it will now appear whether those on the northern correspond with the idea expressed by Mr. Playfair, p. 104, where he gives the *identity* of the *strata* on the opposite sides of *rivers* as one of the proofs that streams have excavated the channels in which they flow.

1262.



employed. We went up the valley of the northern brook, where Mr. Howell shewed me a canal along the foot of one of the hills, by which the stream is conducted from a considerable distance, in order to procure a fall for its mill. This is rather a *combe* than a *valley*; for, as Mr. Howell told me, it terminates three miles above, at the top of the hills. In common seasons, this *brook* is formed only by the springs oozing out on the sides of the *combe*; and when we had ascended the latter a certain way, Mr. Howell shewed me a large artificial reservoir filled by the water of the brook, which is led into it. During violent rains and thaws of snow, the torrent formed by these is turned off, and flows at the bottom of the *combe*; in common times, the whole of the water of the brook enters the reservoir, whence it falls from a certain height into the canal; and in dry seasons, its deficiency is supplied by gradually opening a sluice in the reservoir; but when the drought is of long continuance, the quantity of the water is so small as only to be sufficient to turn the mill-wheel a certain number of hours in the day, sometimes not more than four hours.

1264. From the point where the reservoir is situated, we crossed the hill separating this *brook* from the other, of which I shall only say, that it is equally small; for another object here claims more attention on two accounts; first, as affording a new example of the *dissimilarity* so frequent between the *strata* on the opposite sides of *vallies* and *combes*;  
secondly,

secondly, with respect to the *growan*, that substance which some mineralogists take for *decomposed granite*, as I did myself when I began my observations. The northern side of this new *combe*, formed by the hill that I had just crossed, is composed of *strata* of *schistus*, while the southern consists of *strata* of *growan*; thus it is clearly not the *brook* which has excavated this *combe*. The *growan*, here without any covering, is the same substance that I have described in my detailed account of the mine of *Dol-coath* (§. 1233,) as lying between the *strata* of *kellas*; it must therefore have been produced during the same period as the latter, namely, at the time when our *strata* were formed on the bed of the ancient sea, and not by a *decomposition* of the *granite* on the surface of existing continents; as will soon be shewn by new proofs. On this side, there is a quarry open at the top of the hill; I went up to it, and found the *growan* there in distinct *strata*, *broken*, and variously *inclined*; it is worked as building-stone for the fronts of houses, and is cut into pieces proper for that purpose; but no large masses can be obtained, on account of the very numerous fractures. This *growan* is *unequally indurated*, so that many of the detached pieces are hard only on the surface, the internal part falling into sand; a circumstance which is common also to *sand-stone* in many quarries. I saw here and there in the *strata* of *growan* some wide veins of a beautiful *violet-coloured spar*, and some others of *green spar*: these veins must pass across the whole mass of the hill; for I found a great quantity of frag-

ments of them in the rubbish on the slopes, where the *strata* here and there appear. The *blocks of granite* which are scattered on the top of the same hill are very hard; most of them contain large crystals of *feldspar*; and they so greatly abound here, that, as Mr. Howell told me, they are cut to make kirb-stones for the foot-pavements in some of the new streets of *London*, whither they are sent by sea.

1265. Mr. Howell led me to the lower part of the *combe*, where a lateral brook is received into a reservoir for the purpose of supplying a mill, which, however, it can only do during a few hours in the day. The stream, formed by the junction of all these brooks, is led by a canal through the kitchen gardens of the town, for the purpose of watering them; and being kept at a high level, it is afterwards employed in turning some mills, before it arrives at the level of the sea. In that part, there is a quay, the port of *Penryn* having formerly been much frequented, though it is little used at present: I saw the water come up to this quay, when the tide was in; but when it had retired to a certain point, some small vessels which had ascended with it were left on the mud: and Mr. Howell told me that, at low water, this mud was uncovered to the distance of a mile, the small stream only preserving its course through that space. The exterior accumulation of the sediments of the land-waters being here bounded by the tides, the depth of the water beyond continues to increase, till, as I have said, it becomes sufficient  
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for large ships to lie at anchor. This is a new proof that all these indentations in the land were already existing at the birth of the continent ; for where they were originally the *deepest*, the process of *filling-up*, which has been going on in all, is the least advanced.

1266. After these observations, which, under the guidance of Mr. Howell, I was enabled to make in a short time, I set out for *Killiw*, at the distance of eight miles. From the top of the first eminence, I had a prospect of the lower part of the gulph of *Falmouth*, with its æstuarics, on both sides, between ridges of hills. I then entered the high road ascending from *Falmouth* to *Truroe*, and in following it, I crossed the upper part of the *combes* terminating in the æstuarics on the western side. I thus came into the valley, through which passes the small river *Carn*, in its way to the large æstuary called *Carnan creek*. It is here, as I have said, that the operation called *streaming* has been the longest carried on: I saw marks of it still remaining along the course of the river to a great distance, where the numerous heaps of sand give to all this part of the valley the appearance of a district of mines. The operation is now at an end here, except near the æstuary, where it will also soon be terminated; for as it was begun at so distant a period, the *grains of tin ore* are now almost exhausted. Mr. Gwatkin, in explaining to me this operation, had told me that I should find it still going on at a place on the east of *Falmouth*, which I afterwards visited; and I shall defer describing it  
till

till I speak of that place, because there I shall have occasion, at the same time, to mention such additional circumstances concerning the *growan*, as will throw light on the source of these *grains of tin ore*.

1267. All this road, from the point where I crossed the valley of the *Carnan* to *Killiora*, is interesting in Geology, on account of the multitude of *combes* tending towards the space left vacant by that great *subsidence*, which produced the *gulph* and its ramifications, while still beneath the waters of the sea. It may be judged, from the smallness of the streams comparatively with the size of these *combes*, from the falls and horizontal spaces observed in their course, from the situation of the *strata*, and from their differences on the opposite sides of different *combes*, that the latter are *original features* of the continent, merely softened by superficial causes. But although this is a conclusion of great importance in the history of the earth, and it is only by the number of examples, in frequented places, that it is possible to remove the error, so often repeated, of the *excavation* of vallies by *running waters*, it would take up too much time, were I, at every place, to detail my observations of this class; and though I have always made them very carefully myself, it has been chiefly with a view to judge whether phenomena contrary to this conclusion could any where be discovered; which I have never found to be the case.

1268. At one o'clock I arrived at *Killiw*, where I had again the pleasure of seeing Mr. Polwhele; and here I experienced a new instance of Mr. Gwatkin's kindness, as he had been so good as to invite to meet me, his brother-in-law, Mr. WILLIAM GREGOR, a clergyman, who lives near *Grampond* on the course of the river *Ful*, and whom he requested to be my guide on the eastern side of the gulph: I had already been recommended to this gentleman, and to Mr. Gregor, his elder brother, by Mr. Nott, whom I have so frequently had occasion to mention as having greatly assisted me in these travels by his recommendations. Mr. Gregor lives on the family estate of *Trewarthenick*, near *Tregony*, lying lower on the course of the same river; and as I had several other recommendations for this eastern part of *Comwall*, Mr. Gwatkin was again so good as to make out for me an itinerary for five days, that I might write to the gentlemen whom I wished to find at home, informing them when I should be with them.

*August 4th.* I set out from *Killiw*, at eleven in the morning, with Mr. W. Gregor, who conducted me along a very interesting road, crossing all the streams that enter the æstuaries belonging to the head of the gulph of *Falmouth*; particularly all the branches of the small river *Tresillian*, which falls into *St. Clement's creek*, the most remote of those æstuaries. Here I can only repeat what I have already said with respect to the western side of the gulph.

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If no attention is paid to the state of the *strata* on the sides of the vallies and deep combes through which arrive all the branches of this small stream, and if it either is not known, or is forgotten, that its æstuary is filling up more and more, the vague idea may be entertained that, in the course of *millions of years*, these rills have excavated their channels to the sea, as several geologists have imagined ; but this error cannot be of long continuance, if many people shall be induced, in various places, to become observers of these circumstances, which, as I have elsewhere so frequently described them, I have here only mentioned.

1269. After passing the easternmost branch of the *Tresillian*, we arrived at *Probus*, where we saw the ancient church, remarkable on account of a tower of *granite*, which is covered with ornaments, very delicately sculptured in bas relief, and extremely well preserved. When Mr. Playfair speaks in a note (p. 396) of *the rapidity with which the Cornish granite wastes*, he can only mean the *growan*, of which I have already said so much ; for the *granite* itself is very durable, and its blocks, where fixed in the sandy *growan* on the summit of the hills, are covered with *lichens* ; a proof that they do not suffer any decomposition. Before we reached *Probus*, we had crossed, on a bridge, a great extent of meadows formed on the sediments of the rain-water which had flowed down the surrounding slopes, before they were over-spread by vegetation ; and through these meadows  
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the above-mentioned branch of the *Tresillian* has preserved its channel. The case is the same with the *Fal* at *Grampond*, where we afterwards arrived; this place is supposed to have been originally called, by the Normans, *Grand pont*; there being here another very long bridge, which likewise passes across meadows. This is the parish belonging to Mr. W. Gregor; but he lives at *Creed*, a mile lower on the banks of the river, whither we first went.

1270. We are now come to the *Fal*, that stream, which, had Mr. Playfair ever seen it, he could not have supposed to have cut its way to the sea. From *Creed* we proceeded to *Tregony*, situated below it on the course of the river, in a spot exhibiting a striking view of the effect of the catastrophes undergone by the *strata* of *schistus*, the subsidence of which has formed a large basin, now levelled and covered with meadows, wherein the *Fal* has preserved its channel. The town of *Tregony* has, from a distance, a very picturesque appearance, being built on the declivity of a rocky hill, cut into terraces, on which the houses are placed. Hence we proceeded to *Tre-warthenek*, where we did not find Mr. Gregor at home; but Mrs. GREGOR, having been apprised of our intended visit, had been so good as to have a collation prepared for us in the garden, whence, between the exotic shrubs which the mildness of the climate here allows to flourish in the open air, we had a prospect of a most interesting geological scene,  
formed



formed by the amphitheatre of irregular hills, of which *Tregony* occupies the centre. To Mr. W. Gregor, who studied natural history in various branches, this scene has not been mute: he told me that the aspect of the whole country had long since convinced him of the fallacy of the opinion that *vallies* have been *hollowed out* by *running waters*; as every thing announces that they are the effect of catastrophes; and as, wherever the waters flowing in them have found sufficient space to spread, instead of producing any excavation, they have raised the bottom by their sediments. After having spent an hour very agreeably with Mrs. Gregor, we returned to *Creed*.

*August 5th.* I communicated to Mr. W. Gregor the letters of recommendation with which I was provided for this part of the country from Mr. Nott: I had two, both of them for clergymen; Mr. WHITAKER at *Ruan Lanihorn*, on the borders of one of the branches of the æstuary of the *Fal*, called *Lamorrnan creek*; and Mr. TREMAYNE at *Heligan*, near the coast on the east: Mr. Gwatkin also had given me a letter for another clergyman, Mr. TRIST, of *Veryan*, a place which lies between the two former, and at which, some time ago, had been discovered the only stone in *Cornwall* proper for making lime, except that on the borders of the county, near the *Tamer*: and Mr. W. Gregor very kindly offered to accompany me as far as *Heligan*.

1271. As we were to go first to *Ruan Lanihorn*, we again proceeded from *Creed* to *Tregonu*, in order to cross the *Fal*, and we then ascended some hills bordering the river down to the point still attained by the tides; the space below being occupied by marshes and alder-bushes. Mr. W. Gregor pointed out to me an undertaking which had been begun by his father; that of enclosing and straitening the course of the *Fal*, between two dikes, in order to drain this large space: the plan had succeeded, so far as the dikes had been completed; but as it has not been carried on since the death of the late Mr. GREGOR, the *Fal*, lower down, continues its variable meanders till it enters the æstuary. On our arrival at *Ruan Lanihorn*, we found the late Mr. Whitaker, well known as a celebrated antiquary, recovering from illness, so that I could only have the pleasure of seeing him for a very short time; but as he took interest in the objects of my investigation, he told me that vessels of considerable size are known by tradition to have come formerly almost up to *Tregony*; while at present barges alone can enter this æstuary which they ascend with the tide, but only to a point much below *Tregony*.

1272. From this place we proceeded to *Veryan*, where we fortunately found Mr. Trist, who was so obliging as to accompany us to *Fisher hill*, the place where he had himself discovered the *stratum* of which lime is made: this *stratum* belongs to the mass of the *schisti*, but is distinguished from them by  
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a particular appearance; it makes little effervescence with aqua fortis; yet it produces a very good lime of the kind that hardens under the water; and it is the only one of the *strata* which possesses this property. This *stratum*, as is the case with all those that are followed with any views of advantage to society, is become an interesting object in Geology, because the search carried on for it in other places in the neighbourhood, has rendered manifest the disorder produced in the *strata* by their catastrophes; a circumstance which Mr. Trist was so good as to shew us in *Gerrans bay*, at the distance of three miles, whither he conducted us down a long *combe* which terminates there. Though this *combe* descends from a great distance, I saw no water flowing in it; and I learnt that none of the *combes* on this coast contain brooks capable of turning any mills from Spring to Autumn: whence the mills here have a peculiar name, that of *cuckow-mills*; because their streams being dried up from the time that the cuckow is first heard, the old women say that he drinks up the water. Yet some of these *combes* are of great extent, and have villages in them; that of *Crugsillick* stands in the *combe* by which we descended to the sea.

1273. *Gerrans bay*, like most others, is tending to be filled up: a wide strand called *Pendower beach*, has been formed by the tides and the waves along the cliffs, which are no longer liable to be assailed by the former when they rise to the greatest height; and here again, as well as in other places, there is no occasion

occasion to have recourse to the actions of the sea, in order to explain the formation of such indentations in the coasts; for it is manifest, from the state of the surrounding *strata*, that these indentations are the effect of catastrophes of as ancient a date as the continents themselves. Two principal *combes* terminate at this bay; that by which we came down to it, near the village of *Gwendra*, and another at a mile's distance to the east, very deep, though only a mile in length. On the east of the latter *combe*, the cliffs, as far as the cape called *Pennare point*, exhibit high sections of *schisti*, among which the *stratum* proper for liane is not found; but it appears in the cliff between the two *combes*, where it is seen inclining and passing under other soils forming the western cliffs which consist of *soft strata*, excepting towards the bottom, where appears a *stratum* of *breccia* containing rounded quartzeous masses, and fragments of *schisti*. These cliffs, so different from those which precede them on the east, are the section of soils descending towards the sea with a gentle declivity; near the western cape, called *Pobvadden point*, there are cliffs of the same soft nature, which rise to a greater height; but these are all reduced into taluses, and covered with grass: towards the upper part, the *stratum* used for liane on *Fisher hill* is again found among the *schisti*. These are symptoms of the subversion of the *strata* during their catastrophes, which cannot leave any doubt with respect to the cause of the *vallies* and *combes*, and also of the rupture of these *strata* towards the sea.

1274. After these observations, Mr. W. Gregor and Mr. Trist were so good as to accompany me to *Heligan*, where Mr. Tremayne, who had been apprized of my intended visit, gave me the most obliging reception, and expressed his desire to assist me in all the observations which I wished to make on that coast, as indeed he did in the most effectual manner. This gentleman, truly worthy of his sacred profession, is owner of a beautiful seat at *Heligan*, and gives up to a curate the whole profits of his living; but without neglecting his pastoral duties; for he is always ready to officiate at his own church, or those in the neighbourhood, when his curate, or any other clergyman, is prevented from attending. I received this account, not from himself, for his character is no less modest than virtuous; but from many persons in this part of the country, where his beneficence renders him the object of general affection and esteem.

*August 6th.* The prospect from the windows at *Heligan* towards the sea, formed the first subject of my conversation with Mr. Tremayne. There is a lawn before the house, sloping down to the border of a very deep *combe*; and beyond this rises a hill, over which I saw, at no great distance, the spire of the steeple of *Mevagizey*, a small town by the seaside. This led me to shew him the passage in Mr. Playfair's work, relative to the operations of the smallest streams on this coast of *Cornwall*, there supposed to be continually deepening the vallies  
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brough which they arrive at the sea; and I told him that it appeared to me impossible that the *combe* lying before us, in a direction at first parallel to the coast, and then turning almost at right angles to arrive thither, could have been excavated by the little rill which I perceived flowing in it. To this Mr. Tremayne replied, that nobody could have formed such an idea, who had ever fixed his attention on the courses followed by streams in their way to the sea, or on what passes upon the coasts; as I should have an opportunity of seeing in an excursion on which he meant to accompany me.

1275. Mr. ROBYNS, the clergyman of *Mevagizey*, happening to come this morning to *Heligan*, Mr. Tremayne proposed that we should accompany him, on his return home, by a road which would give me some idea of the neighbouring country. We first crossed the upper part of the large *combe*, and ascended the hill beyond it, where Mr. Tremayne has a summer-house, commanding a view of the sea, as well as of several *combes* that laterally join the lower part of the former, and terminate, together with it, at a small bay, around which *Mevagizey* is built. This is another of the ports that the sea is tending to fill up: no vessels can any longer enter it but at high water, and when the tide is out, they are aground in the sand. We went down the *combe* to the point where it bends to reach the shore; and that this *combe*, as well as those which join it, have all been produced by the catastrophes of the *strata*,

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is evidently shewn by the difference between the sides: in the steep sides, the sections of the *strata* are covered with trees; while those which are opposite to them, and have less declivity, being formed by the planes of the *strata*, are either in tillage, or covered with grass. All the waters flowing in these *combes* in common seasons proceed from springs issuing from between the *strata*; and when collected at the bottom, they are only sufficient for a *cuckoo-mill*.

1276. Mr. Tremayne's plan for this day was to take me to one of the places where the operation of *streaming* has been continued the longest and is not yet abandoned, and where much light is thrown on this object by local circumstances. The work is at present going on in the lower part of a valley which descends from *St. Austle*, in a direction from north to south, into the bay of *Pentuan*, whither we first went. In passing by *Pengrugla* and *Peruppa*, Mr. Tremayne pointed out to me some very deep *combes*, terminating, together with many others, in the valley of *St. Austle*, in which, however, there flows only a small stream. From the top of the last eminence of this side, we had a view of a fine amphitheatre of hills around the bay, bounded on the N. E. by a cape called the *Black head*, forming the highest part of the ridge which it here terminates. On the *Mecogizey* side, the bay is bounded by another cape called *Pennera point*. When we arrived on the strand of the bay, I observed in the cliffs on the latter side a  
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phenomenon that I had also seen in some parts of the Alps; consisting of *schistose strata*, which, having been crushed by some concussion of the bottom of the sea before they were consolidated, have assumed, in consequence, singular contorted appearances; but having, when indurated, been covered by other *strata* subsequently formed upon them, they have undergone, together with the latter, the same great fractures, subsidences, and angular motions, which are commonly found in strata of the same class, and which have rendered these nearly vertical.

1277. We seldom see, on coasts, such evident monuments as are here found of the catastrophe which produced the bed of the present sea, together with the cliffs, and those indentations of the continents that form bays and gulphs: everywhere, indeed, we perceive the *filling-up* of these recesses, the progress of which operation within known times may even be traced by tradition; sometimes also *rocks*, originally in the sea, are encompassed with its sand brought by its actions into bays; but such *rocks* are generally the only indications extant of the state of the heads of *bays* at the origin of the continents, and of all which has since passed on the coast; while, for the history of this *bay* we are partly indebted to the labours of man.

1278. The exterior proof of a progressive *filling-up*, within an inconsiderable space of time, is here first afforded by some *rocks*, originally, as I have



just said, in the sea, but now surrounded with sand: Mr. Tremayne shewed me one of these, which is remarkable enough to have been taken as a boundary between two parishes; in his youth he had seen this rock surrounded by the high tides, though at present they do not come near it. The accumulation of the sand is here of a very great extent; and as but little water enters the bay from the land, the winds have raised a ridge of *dunes*, by which, in the innermost part of the bay, the passage is closed against the tides; and in consequence, this part is now become a marsh, like that in *Mount's-bay*, of which I have already detailed the particulars. Mr. Tremayne, to whose estate this space belongs, has undertaken to drain it; he has caused to be dug in it deep ditches, communicating with a canal which passes under the *dunes* with a sluice; and the marshy soil is now beginning to yield good herbage. But the following circumstances are proofs to the same effect, more complete, and in many respects more interesting.

1279. The operation called *streaming* has been carried on during many centuries in the valley of *St. Austle*; but with more skill and economy than in that of *Carnan*, already described. This valley extends inland beyond *St. Austle*, and comes down to the bay. The *stream-work* was begun above the town; but in all the part where it has been completed, the sand, when washed, has been thrown back to fill up the excavations, and the waters of the small  
stream,

m, employed in this operation, have progressively changed these grounds into meadow-land. In this manner the work has been continued down the lower part of the valley, where it is become more laborious, on account of the thickness of the soil which must be cleared away. It is always necessary to go down to the *schistus*, forming the natural bottom of the valley, because the *grains of ore*, being the heaviest bodies, are accumulated there, mixed with the loose *growan* washed down from the hills. Mr. Tremayne led me into the excavation where the work was then going on; and the different kind of materials, which we cleared away in order to arrive at the *tin grains*, furnish a complete history of the filling up of the bay.

180. The extremity of the valley which descends from the north originally formed a *creek*; and the *growan* which has brought down into it by the land-waters, was spread over its bottom under the sea-water; for the *grains of ore* are here found at a level below that of the sea. This is a circumstance, however, not attended with any inconvenience, because the great accumulation of these materials, through which it is necessary to dig, forms an impenetrable dike against the tides and the winds. The *ore* is found, as I have said, on a *schist*-bottom, but not merely in small grains; there are large masses of it, besides fragments of a *vein*, and the *ore* retains a part of its gangue: nor is it in the principal ancient *creek*, which forms the mouth of the valley of *St. Austle*, that this ore is

taken up; for similar works are carried on in small lateral *creeks*, the lower part of *combes* whence brooks proceed: now in all these the following different kinds of materials, of which I here saw the section, have been spread over the original bottom. The *growan*, wherein is found the tin ore, is covered first with a very thick stratum of a blackish mire, containing remains of vegetables in great abundance; among these were shewn me some mosses, very well preserved, and some nuts, of which the shells were become blackish and brittle, and the kernels were much decayed. Over this stratum is spread sea-sand, mixed with a great quantity of shells of the same kinds that are now found on the outer strand, principally *chamæ* and *ostræ*; and this sand, as it is removed, is heaped up on the side in order to be spread over the land, for which the shells render it a proper dressing. Here also, as is the case in many of the bays already described, this sand is covered, even below the level of the sea, with *peat* which has flowed down from the valley; and this, when it is cut, is likewise put aside, and is used for fuel. Lastly, when the *streaming* began in the higher part of the valley, the loose *growan* was washed down hither by the little stream, and spread over this *peat*, where it mingled with the sea-sand, thrown up by the waves here, as well as all along the bay. This stream has had its course turned, from the point where the excavation passes below the level of the sea, and it now discharges itself on another part of the strand; but as water is wanted to put in motion  
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umps placed at the bottom of the excavation, for the purpose of pounding the masses of ore con- with their gangue, a rill has been led to the place whence it falls on a wheel; and the latter is not only the stamps, but a pump serving to raise the water which has put it in motion.

This therefore, was a very important place of excavation; because a motive of interest having induced men to dig down to the bottom of the bay, the work here has brought to view clear monuments of which ever since the continent has existed; monuments which are obliterated in all the bays where the same motive has led to the examination of these monuments. After having observed this place, I visited the valley of *St. Austle*, whence Mr. Tremayne led me to a spot on a hill which is called *St. Austle*, a mile and a half on the east of the town, where I was struck with the appearance of works of a different kind. Mr. Tremayne was here obliged to depart, as he had an engagement at home; but he recommended me to the conductor of these works, a prudent man, who explained them to me with the necessary details.

To such of my readers as are acquainted with the *Alps*, I cannot give a more exact idea of the appearance which here presented itself to my view, by comparing it to certain high combes in those mountains as surrounded with obelisks. There is on the

the top of *Cruglaze* a vast excavation; and proportionally as this is extended, pyramidal projections are successively formed around it, in consequence of the nature of the mass of the hill, which, in the eastern part of the summit, where the work is carried on, consists of *strata of growan*, very much inclined, and alternately hard and soft. As the excavation, already at the depth of one hundred feet, with a considerable breadth, is farther enlarged, the soft *strata* crumble down, and those which are harder are left alone; the latter, however, not being very hard, wear away also at their summit, and thus by degrees, assume the pyramidal form; in this respect resembling likewise the *Needles* of the *Isle of Wight*.

1283. This is the place to which I alluded, § 1266, as tending to unfold the origin of the *tin ore* scattered in *grains* over the bottom of some of the Cornish vallies, and particularly this of *St. Austle*: the whole mass of the *strata of growan*, composing the eastern part of the hill, contains these *grains*; but it is in the hardest *strata*, which are those here worked, that they are found in the greatest abundance: and in this spot every thing combines in proving that *growan* is not a *decomposition* of *granite*, but a precipitation *sui generis*, formed on the *strata of schistus*; for it has all the characters common to so many other kinds of *strata* alternately soft and hard, which were at first horizontal, but have since undergone fractures and angular movements. The soft *strata*, alternating with the harder, and containing but few  
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tin grains, have none of the elements of *granite*, except the crystals of *quartz*, which are mixed with a *white clay* very soft to the touch; and the conductor of the works told me that it would be proper for the composition of china, if it were not intermingled with very small black grains, from which there was scarcely a possibility of separating it: these grains, here called *cochle*, appeared to me to be *schorls*. The *strata* containing the greatest abundance of *tin grains* are harder, as I have said above, but they are easily decomposed; so that, as the greater part of the hill consists of them, it is probable that, soon after the birth of the continents, and before the surface had been bound by vegetation, (very thin on these hills, which are covered with heath,) the rains had washed down into the vallies a great quantity of this *growan* with its *tin grains*. I shall also shew, in the sequel, the probable origin of the masses which appear to have belonged to a *vein*.

1284. This hill has been worked for a long time, but former adventurers had stopped at an inconsiderable depth; they had only dug a canal, as low as they had found it practicable, towards the slope on the side next *St. Austle*, which served to carry off the water from the excavation, while at the same time the materials were brought out by it in a little boat; but the present adventurer has formed a more extensive plan. In order to carry off the waters to a greater depth, he has availed himself of a combe in the slope of the hill: he first dug vertically on that  
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side to the depth of one hundred feet, stopping at a point from which the declivity of the *adit* towards its opening into the combe might be sufficient for the water passing down that way to sweep along with it, by its rapidity, the materials placed in its course; his design being to carry on all the labour of stamping and washing the ore within the excavation, and to drive out of it all the dross, by means of the water thus employed. A rill, introduced into the excavation by wooden troughs, falls there on the wheel of the stamps; under these is made to pass all the *growan* detached from the sides of the cavity, of which the extension is continued at the same depth, and the *tin grains* are, for the most part, retained within, while every thing else is carried away by the water in the *adit*; at the opening, however, of the latter into the combe, are placed several successive large troughs, in which the water, as it passes, deposits the minute *tin grains* that have so far floated in it.

1285. Besides the strong inclination produced in these *strata* of *growan* by their catastrophes, they have, as has been said, undergone great fractures, which are filled up with a substance so much resembling *growan*, that the workmen make no distinction between them; but these were pointed out to me by the conductor of the work, especially because the relative level of the *strata* has changed on their sides, in some places very considerably: these first fractures, like the loads of this country, have themselves experienced subsequent fractures; so  
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that, in their descent, they do not follow a regular line. He shewed me also some *gossens*, those small fissures filled with quartz which I have already described: and on the sides of these *strata* have undergone as great changes of relative level, as on the sides of the *loads*.

1286. In surveying this hill, on the summit of which there are only insensible inflections, rounded and covered with heath, no one would suspect that such great symptoms of catastrophes were concealed within it. Here therefore, as is the case in so many other places, it is to the labour of men, in pursuit of their private advantage, that Geology is indebted for the removal of the veil spread by vegetation over the ruinous state to which the bed of the ancient sea, now become our continents, had been reduced by successive catastrophes: a state whereby it was so advantageously prepared for the habitation of men, and the exercise of their industry. And with respect to the interior disorder of the strata, a more surprising circumstance occurs here, than is commonly met with in other places; namely, a total dissimilarity between the nature of the slope on the *St. Austle* side, and of all the rest of the hill. (On that side there is a great cleft, by which the workmen enter the excavation, descending to the bottom by ladders, as I had done myself. The undertaker of this extraordinary work accompanied me on my return; and when we came to this passage, he pointed out to me that, within a certain space, both its sides consist



consist of *growan*; while beyond, both the sides, as far as the opening outwards, are of *schistus*, which afterwards forms the slope of the hill; but, at the point of junction of these two different kinds of *strata*, there is such a chaos, that it is impossible to judge in what manner they are united. In these *schisti* there are *veins* of *tin*, which after having been followed for some time, were abandoned, because they became poor; however my conductor had determined to resume the exploration of the most promising vein, of which I heard farther particulars the following day.

1287. From this hill I returned to *St. Austle*, and then to *Heligan*, passing, in the road between these two places, near a very ancient mine, called *Polgooth tin mine*, which Mr. Tremayne had mentioned to me, and to which I paid more attention when I again passed this way the next day with him; for he shewed me the same kindness in assisting me to continue my journey which I had already so frequently experienced in this county. General Simcoe had given me letters of recommendation to Mr. PHILIP RASHLEIGH at *McNabilly*, situated at the eastern extremity of the succeeding bay, and to his brother Mr. CHARLES RASHLEIGH, who lives at *Polmear*, on the western side of the same bay; and Mr. Tremayne, being brother-in-law to the latter gentleman, had invited him to meet me at *St. Austle*, that he might be my guide from that place to his own house. Mr. Tremayne himself was so good as to accompany

accompany me as far as *St. Austle*, in order to explain to me the circumstances relative to *Polgooth tin mine*, which lies, as I have said, near the road.

*August 7th.* We set out from *Heligan* at eleven o'clock; and on coming to the brow of a high hill above *Polgooth mine*, I saw very evidently, from the immense heaps of sand cast out from its stamps, which covered a great extent of ground, that it must be, as I had been told it was, one of the most ancient in *Cornwall*. This is again a very remarkable mine, and I should have been glad to visit it, in order to make some inquiries of the miners with respect to its connections with the neighbouring grounds; I had not, however, time for this, on account of my numerous engagements on the road: but the particulars of which I was informed by Mr. Tremayne may convey a sufficient idea of the nature of the spot. Here, in a low space of considerable extent, rises a small hill of *schistus*, absolutely insulated, a mile and a half in length, very rapid on the side next *Heligan*, but descending towards the valley of *St. Austle* with a gentle slope. A very rich *tin load* passed through this hill, out of which almost the whole of it has now been taken, its continuation being at present followed much below the exterior basis of the hill: the shafts, by which the ore is still brought up, and in which is the machinery of the pumps, have been sunk from the summit. No stream passing here can have insulated this hill; and as it contains a *load* that extends below its base, it can only have become  
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an *eminence* in consequence of *subsidences* posterior to the formation of the *load*.

1288. On our arrival at *St. Austle*, Mr. Tre-mayne, who was again obliged to return to *Heligan*, was so good as to take me to the house of Mr. R. HENNACK, the clergyman of the parish, where I might wait for the arrival of Mr. C. Rashleigh; nor did the time appear to me long; as I received much useful information from this gentleman, who was respectable from his age, his character, and his knowledge, and whom I found much interested in the objects of Geology. From him I learnt many circumstances respecting the mines of this county; but I shall here confine myself to those relative to *Cruglaze hill*, where I had been the day before. Near the junction of the *growan* with the *schistus*, there is a true *load* containing *tin*, which has been worked from a period anterior to all the records of the country, and has always borne (it is not known for what reason) the name of *Delamine*. The direction of this *load* is from east to west, and it has been worked to the length of one hundred and seventy fathom; it follows the *kellas*, or *schistus*, which it never enters, and which lies to the southward of it, in some parts at the distance of only eight feet, but in others of twenty feet. This vein is therefore in the part of the *growan* nearest to the valley of *St. Austle*, in the lower extremity of which, at *Pentuan*, on digging down to the schistose bottom, is found *tin ore* obviously once forming part of a *vein*, mixed with the *tin grains* belonging to the *growan*:

*growan*: may not that ore consist of fragments of the vein just mentioned? I communicated this idea to Mr. Hennack, and he thought it very probable.

1289. When Mr. C. Rashleigh arrived, I set out with him for *Polmear*, which has now changed its name, as I shall presently have occasion to mention. On quitting *St. Austle*, our road lay over a high hill on the S. E. and from its top I saw the ground first descending towards a large plain, then rising near the coast in hills much intersected. The part of the coast here lying before us was *St. Austle's bay*, which is separated by a cape, on the east, from the course of the river *Fowey*, and by another on the west, namely, the *Blackhead*, from *Pentuan bay*. We proceeded towards *Polmear*, situated in the lower part of a combe, which forms a cove in *St. Austle's bay*, between two small capes. Mr. C. Rashleigh, considering this situation, had formed the project of establishing a port here; it being much wanted by a very extensive tract around this bay, which has no communication but over hills with the ports of *Fowey* on the east, and of *Falmouth* on the west; while, besides the consumption of the country, and the pilchard fishery, carried on in this bay with great success, a new object of exportation has for some time presented itself here. There is found in the neighbourhood a kind of *growan* resembling that of *Cruglaze hill*, as it consists of crystals of quartz, imbedded in a white clay, proper for the use of the china manufactures, because it does not contain any  
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of those blackish grains called *cochle*, which are in that of *Cruglaze*. A succession of troughs has therefore been made, for the purpose of diluting and washing this *white clay*, and separating it, not only from the *crystals* of *quartz*, but from every other impurity; and it is then made into cakes, which are exported in great quantities; formerly, these were sent to *Falmouth* for embarkation; but besides the expense of the carriage over the hills, many of them were then broken and reduced to powder.

1290. Mr. C. Rashleigh, therefore, perceiving that a port in this cove would naturally be much frequented, formed the design of establishing one, together with a dock, for the purpose of building and repairing vessels; the magnitude of the enterprize did not discourage him, and it has proved successful. He began by purchasing around the cove a large space of uncultivated land, extending to the coast; and having it thus entirely at his own disposal, he first secured its entrance against the waves by a circular mole with a sluice; procuring materials for that purpose by cutting away the schisti on the sides of the cove; and in this manner he formed a port sufficient for the commerce of the place, which, vessels enter at high water, being kept afloat in it by closing the sluice. Afterwards, continuing to excavate in the schisti, he formed the space required for the dock; and as there would have been too great difficulty in keeping it dry against the tides, in order that vessels might enter and go out with them, he made it above  
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their level with a lock. But this could not be effected without the assistance of land-waters ; and hence it will manifestly appear that these have not been the agents which have excavated the *combe* and the *cove* of *Polmear* ; for only a rivulet arrives here, and it is often dry. This, indeed, has been Mr. Rashleigh's chief difficulty ; and he has been obliged to bring water from a considerable distance, that there may be always a sufficient quantity to make the vessels ascend into the dock, and descend from it ; which, however, requires a length of time, because the supply of water is very small.

1291. The port and dock being finished, the next object was to produce activity in them. With this view, Mr. C. Rashleigh first undertook the curing of pilchards on a great scale ; and he was so good as to take me to the place where it was carried on, that I might see the whole process ; which, however, I shall not describe, it being very generally known. A great quantity of oil being extracted from the fish, Mr. C. Rashleigh employs the dregs of it to great advantage in the amelioration of his lands recently brought into tillage. These dregs are poured on mud taken out of the beds of the brooks and the ditches by the road-sides ; and, when fully penetrated with them, this mud is spread over the corn-fields, in several of which I saw rich crops. The pilchard fishery, and all the labour required in it till the barrels are closed and deposited in the cellar, the building and repairing of ships, the business of the  
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port in the loading and unloading of vessels, which by degrees has very much increased, together with the progress of agriculture, have occasioned so many new houses to be built at *Polmear*, that it is become a small town, and, from the name of Mr. Charles Rashleigh, is now called *Charles Town*, as I have seen it designated in a recent map of *Cornwall*.

1292. Mr. C. Rashleigh was then so good as to lead me down to the bay, where a wide strand is continuing to extend itself. The waves have carried the gravel up to the foot of the cliffs, which, however, are still crumbling down, because they consist of foliated schistus, shattered by innumerable fractures, and the beach is not yet high enough to prevent the waves from reaching their foot at high water; but this will take place in time, when the strand shall become wider. We afterwards ascended the hill, on which stands Mr. C. Rashleigh's house; he invited me to rest myself there till the following day; but, on account of all the appointments which I had made on the road by my letters from *Killiw*, I was obliged to deny myself that pleasure, and to set out again after dinner, that I might reach *Menabilly*, the seat of his brother Mr. PHILLIP RASHLEIGH, the same evening.

1293. *Menabilly* is at the eastern extremity of the bay, on a promontory forming the continuation of the eastern side of a wide æstuary, which, at low water, may be crossed on the strand: Mr. C.  
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Rashleigh thought I might arrive there in time to cross this way; but I had staid too late at his house; so that, when I came to the passage, I found it already covered by the tide; and as I did not like to venture through the water in my chaise, I was obliged to go a great way round, in order to cross the estuary on what appeared to me a dike, between *Trenovissick* and *Par*; in consequence of which delay, it was eleven o'clock at night before I arrived at *Menabilly*. I was much concerned at this accident, because I knew that Mr. P. Rashleigh was a great invalid with the gout, and I was afraid he might be already gone to bed. I sent my driver to the house, with General Simcoe's letter, ordering him to inquire whether I could be conveniently received there at so late an hour: Mr. Rashleigh was still up, and sent me a most obliging invitation, which I immediately accepted, and when I had explained to him what were the particular objects of my observation in this journey, he told me that the estuary which I had now crossed in the dusk of the evening was very remarkable on many accounts; and he offered to take me to see it the next morning in his carriage.

*August 8.* Mr. Rashleigh was so good as first to shew me his cabinet of minerals, arranged in glass cases. I had never seen any where so fine a display of mineralogical specimens of all genera and species, not only from the Cornish mines, but from those of many other countries; Mr. Rashleigh hav-



ing availed himself of every opportunity of enriching his collection, by exchanges with the mineralogists of the continent. When we have before our eyes this astonishing variety of the products of the mines; groups of crystals of so many distinct species, accumulated one on another, which have been formed in cavities only, and certainly at different periods; it is impossible not to perceive the error of those who suppose these materials to have been raised up and injected, while in *fusion*, into the *fissures* of the *strata*. Mr. Rashleigh has likewise in his garden a grotto, which alone might be considered as a cabinet of mineralogy, from the variety of the beautiful minerals wherewith it is adorned.

1294. We then went out in the carriage, to observe the *creek* of which I have already spoken. With this view, we went first to that remote part where I had crossed it the evening before, on what I had then taken for a dike; but this is, in fact, a very broad *beach* raised here by the waves, which can no longer pass over it, because they lose much of their rapidity, even at high water, on the very wide strand formed around the whole bay. Thus all the remote part of this creek, which is of great extent, and has evidently been occupied by the sea, is now separated from it. Moreover, it is positively known by tradition, that, in ancient times, this whole space was covered by the tides: Mr. Rashleigh himself remembers that, in his youth, he had seen them enter it a considerable way, and that a  
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great part of it was then marshy: but it has since been filled up so fast by the sediments of the waters both of the land and of the sea, and the outer strand has been so much raised and extended, that the course of the tides is now bounded by this beach. Mr. Rashleigh told me that, at the time of the spring-tides, the water, during the reflux, retires to more than a mile's distance; and that, all the sediments of the land waters being retained within the beach, every part of the strand without, as soon as it is abandoned by the tides, may be passed over in carriages, and even with loaded waggons, it being entirely composed of gravel and pure sea sand. The inner space has been converted into good meadows, by cutting a strait and deep channel for the small river *Par*, which enters the head of this ancient creek, and is there joined by some brooks.

1295. But the object of observation which here most interested me, and which Mr. Rashleigh had previously mentioned to me as shewing that *running waters*, when they began to flow, had followed to the sea the channels originally formed by the catastrophes of the strata, was the entrance of the *Par* into this space, wholly surrounded by hills, of which those towards the head are of considerable height. We had already entered the meadows, before I could judge whence this small river arrived to flow in them: but Mr. Rashleigh took me to a bridge near *St. Blaxey*, where I saw it issuing from a deep valley. I ascended the hill on its right bank,

belonging to a *schistose* ridge that borders the coast. Hence I saw the valley of the *Par*, which has at its origin a direction from west to east, turn nearly at right angles, and intersect the hills here forming the left bank; these lofty eminences are studded with *rocks of granite*, while there are none on the opposite side, which is much lower. I was told that Mr. Playfair had passed along this coast; I could wish that he had gone up to *St. Blazey*. Returning hence by the eastern side of the ancient creek, we passed before the opening of a *combe*, down which a brook flows, continuing its course through the sand that has filled up the lower part; for this brook also a strait and deep channel has been cut, and with the sand taken out, banks have been raised along its sides, in order to serve as dikes for the meadows which border it. We returned to *Menabilly* at half past one o'clock.

1296. I had appointed to be this day at *Ethy*, the seat of Captain Penrose; so that I could no longer accept Mr. Rashleigh's hospitality, but took leave of him at five o'clock. The distance from *Menabilly* to *Ethy* would be only four miles, if a strait road could be made from one place to the other; but in the interval lies a deep defile, through which the small river *Fowey*, one of those particularly mentioned by Mr. Playfair as favouring his system respecting the actions of *rivers*, takes its way to the sea: its course must be ascended as high as *Lostwithiel*, in order to cross it before it enters this defile.

file. Till I came within about two miles of *Lostwithiel*, I travelled over low hills of *schistus*, the continuation of the ridge bordering the creek of *St. Blazey*; several of these hills shew on their summit sections of the *schistose strata*, inclining inwards, but with different directions in different hills; whence it evidently appears that these are only the remains of *strata*. I then entered the high road which traverses this part of *Cornwall* from west to east. At this point the scene changes very much; hitherto I had seen no *blocks of granite*; but I now found the hills, along which the road passes, entirely covered with them, on a soil of *growan*; the latter is so hard, that, at the foot of these hills, there are several quarries whence it is taken as building stone; I remarked in it some yellow stripes, not following the *strata*, but waving in a singular form; a phenomenon which I have elsewhere often seen on sections of *strata of sand-stone*. In the descent towards *Lostwithiel*, where the soil is cut down to a great depth for the road, I saw this *growan*, in some places, resting on a base of *schistus*.

1297. *Lostwithiel* is built on the slope of one of these hills bordered by large meadows, through which the *Fowey* flows before it enters the defile that leads it to the sea. These meadows are passed over in a long causeway with several openings to carry off the waters during inundations; but in common seasons, the river flows under a single arch, as was the case at present, with so slow a course, that, in order  
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to make it turn a mill, a canal has been cut from the bridge, wherein it is kept up at a certain height along the foot of the hill, till it can have a sufficient fall. Several *combes* meet in this space, which is of great extent, and nearly horizontal, its bottom having been levelled by the sand brought down from the hills, before they were covered by vegetation. The small river has preserved a channel for itself through this alluvial soil; and its water being very low, I saw on its sides the section of this soil, which is composed almost wholly of sand.

1298. After having crossed these meadows, I turned into a road over the southern hills to *St. Winnoe*, situated in a wide part of the defile, on the borders of the æstuary, which there already I saw beginning to be filled up. Thence I ascended a hill to *Ethy*, where Captain Penrose received me with all the cordiality expressed in his invitation, and where I spent the evenings of this and the following day enjoying the society of a family, in which were recalled to my mind the descriptions given of the rational life led by country gentlemen in former times. Captain Penrose first spoke to me of the two objects which had induced him to regret his not having known my name at our former meeting at *Padstow*; one of these was, that, in the northern part of the peninsula, by the side of the gulph of the *Camel*, there is found, among the *schistose strata*, a *stratum* which is proper for making lime, and sufficiently compact to take the polish of marble; a  
phenomenon

phenomenon of the same kind as that already described on the south of the peninsula, near *Gerrans bay*. The other phenomenon was a great and sudden *subsidence*, which took place some time since in the upper part of the promontory of *Padstow*. A farmer had but just passed over the spot with a cart, when all at once a piece of ground, 100 feet in diameter, sunk in, and formed a deep pit. This, though so long suspended, belongs to the series of the ancient *subsidences*; and I have seen several examples of the same kind in *Germany*. I then communicated to Captain Penrose what is said of the river *Fowey* by Mr. Playfair, who places it in the number of those streams, which, flowing originally at a higher level than that of the rocks on the coasts, have cut, through those rocks, their channels to the sea: he was very much surprised at this idea, and told me that, the next day, he would show me proofs to the contrary.

*August 9.* The excursion which I made this day with Captain Penrose, for the purpose of observation, was truly a party of pleasure; as we went almost the whole way on the water, and the weather was perfectly serene and calm. In order to give me a first idea of the long defile which the *Fowey* enters at *Lostwithiel*, and to shew me how little it corresponds with Mr. Playfair's account of such chasms, in p. 105, where he says that *streams* have cut them, "in the same way, and almost with the same instrument, by which the lapidary divides a  
" block

of marble or granite," Captain Penrose led me to the eastern side of this deep channel, to a projecting rock surrounded by large trees, which, from its root, raise their highest branches above its summit: amidst these he has placed a summer-house, covered with a green trellis, where I could have fancied myself in an eagle's eyry. Hence there is a view of the defile to a great extent, both above and below; and it cannot possibly excite any other idea than that of its having been produced by a fracture, with the *subsidence*, here and there, of large masses of *strata*, and *angular motions*, much varied, of the several masses which have remained at a higher level; for in some parts there are great recesses on the sides, and in others many projecting rocks of *schisti*, with their *strata* inclined towards different points.

1299. We then descended a very steep hill, covered with an oak coppice, through which the road is cut in the *schisti*, and their *strata* are seen to dip very rapidly into the interior part of the hill. We thus descended to the bottom of a *combe*, with only a little rivulet flowing in it; the lower part of this is a small *estuary*, at the extremity of which Captain Penrose has built a large boat-house, where three boats of different sizes lie under cover; they enter it at middle tide, and are kept within it by barred folding gates. Now the following is the first of the proofs which he gave me that the river and the sea, instead of having opened this passage, are constantly employed

employed in raising its bottom: the sand, entering this boat-house with the tides, accumulates there to such a degree, that it is frequently necessary to clear it away, in order that the boats may be brought out before the time of high water. We found the boat which was intended for our little voyage already afloat; and having embarked in it, we issued from this creek into a large lateral *æstuary*, extending inland a considerable way: through this passes, to join the *Fowey*, a stream, which, though very small, is the largest of those that fall into that river within the defile. This stream is called the *Lerring*, and the *æstuary Lerring creek*, from the name of a village at the extremity of the latter; now as, at the point of its junction with the *Fowey*, there is no difference, either in breadth, or in the height of the sides, between this lateral channel, and that of the river itself, it is evident that so small a stream cannot here have cut a passage so disproportionate to its size.

1300. The tide was at its highest point when we came out of *Lerring creek*; and after having sailed but a very little way towards the sea, we found ourselves, to all appearance, in a lake, surrounded with hills which are embellished by the trees growing between their rocks. This defile winds so much, and contains so many wide spaces, that, for a great way, we were continually passing out of one of these seeming lakes into another. We sailed along in front of a second great branch of the defile, on its  
left



left side, likewise forming an æstuary, which is called *Trevillian creek*, from the name of a village at its extremity; and through this also, as I learnt from Captain Penrose, only a rivulet flows. We thus entered an extensive space, resembling a much larger lake, encompassed with hills, which the accidents of the rocks intermixed with trees and verdure render extremely picturesque: a wide and deep æstuary, called *Polruan creek* from the name of a neighbouring village, opens on the eastern side of this space; and on the opposite side, upon the slope of a hill formed into terraces adorned with gardens, is the town of *Fowey*, with its port in front. We were now in a gulph, the entrance of which is on the *Polruan* side; and though we had nearly reached this entrance, I did not yet perceive it. The hills, here bordering the coast on the west, and stretching across the gulph, approach so near to those on the eastern side, that anciently the passage was closed by a chain; and on both sides are still seen the towers which contained the machines employed in letting down this chain and raising it. If Mr. Playfair had come hither, could he possibly have supposed the small river *Fowey* to have excavated this large space, and cut its channel to the sea, while its current here is absolutely insensible?

1301. Going out to the sea, we found its surface like a looking-glass; so that we could row very near the coast, where the rocks thrown down on the slopes, and extending under water a considerable way,

way, present an image of the confusion which was produced at the epoch of the formation of the present bed of the sea. It cannot here be said that the actions of the sea occasion the fall of such masses by *wearing away* the bases of the rocks; for these bases, along the whole coast, as well as many scattered rocks rising above water in its front, are covered, up to the level of the highest tides, with *barnacles* and *limpets*, over which crawl multitudes of small perriwinkles. The *barnacles* appear motionless; and the *limpets*, though they move slowly, are equally secure from being detached by the strongest waves; because waves, at their contact with the rocks, only rise and descend, without any sensible *friction*, as is the case with *liquids*; and I have elsewhere already remarked, that the great noise made by waves when they dash against the coasts, from which it has been supposed that they attack our continents with violence, is produced only by the vast quantity of air disengaged from water when it falls back on itself. Captain Penrose told me, that the *spawn* of the *barnacles* abounds so greatly in the water on this coast, that, within a very short time all the piles driven here in the sea are covered with these little shells, as are likewise the bottoms of the ships, if not coppered. The tide being still high, we entered a grotto in the rocks, which is sufficiently spacious to receive Captain Penrose's largest boat; he has dined here in that boat, with a party of twelve people. It is evident that the waves do not excavate this grotto, for it is lined all around with

with *barnacles*; and when the disorder of the *strata* is observed within it, the chaos of the masses without no longer excites any astonishment.

1302. The ebbing of the tide obliged us to return to the gulph sooner than we should have desired; but too long a delay would have rendered it impossible to lay up the boat. The water was already low enough to discover on the rocks all round the gulph a broad zone of *barnacles*; as we proceeded, we saw this zone intermixed with *fuci*, which afterwards prevailed alone as far up in the gulph as it is constantly occupied by salt water; as the sediments of the tides are not yet raised to its highest level. We had remained on the coast a little too late; so that we could scarcely enter far enough into *Lerring creek*, to lay up the boat in safety till the tide should be again sufficiently high to carry it into the boat-house. This æstuary is already so much filled up, that, above the point at which we quitted the boat, the rivulet flowed alone, following the channel of the retreating tides. As we reascended the hill, we saw the dry space increase in extent; and it was the same on the course of the Fowey, then flowing alone in its æstuary: the meadows through which the river passes near *Lostwithiel* accompany it already some way down the æstuary; and it is observed that they are continuing to extend themselves. I spent the evening no less profitably than agreeably. Captain Penrose, having been stationed in the West Indies, has availed himself of that opportunity

unity of making a very interesting collection of shells and other marine bodies, and of observing, at the same time, the motions of the former along the rocks, together with the various positions of those works of the sea polypi, madrepores and corals; of the latter, many no longer exist in the European seas, though they are found in great abundance in some of our calcareous strata.

*August 10th.* After having had the pleasure of spending part of the morning with the family at *Ethy*, I set out to the eastward for *Catchfrench*, the seat of Mr. GLANVILLE, one of the members for this county; who, as I have said before, had been so good as to invite me to his house, that I might observe the very remarkable course of the river *Seaton*, which discharges itself into the sea in his neighbourhood.

1303. On quitting *Ethy*, I first ascended some high hills covered with heath on a whitish argillaceous soil; this soil is of great thickness; for though there were deep clefts in it, I could not anywhere perceive the schisti: the surface is covered with masses and gravel of quartz. On this ridge begin the *combes* already mentioned as coming down to the meadows near *Lostwithiel*, which I saw from the upper part of each in succession; but these *combes* are not all of the same form, some of them being much wider above than they are below, and others the reverse. At the top of the last of these *combes*,  
I entered

just crossed, have not, like them, on their surface, which is also composed of *schistose* rubbish, any fragments of *quartz*; no stones being scattered here, but some blocks of the *iron stone*. As I continued to travel along this road, I came within sight of a new system of waters, proceeding from a multitude of small *combes* all turned towards the valley wherein is formed the little river *Seaton*, which also discharges itself into *Witsand bay*; and Mr. Glanville's house was shewn to me upon a very pleasant hill on the opposite side. In my way thither, I went down into the valley, where, though it is very deep, the river which flows in it is so small, as to be crossed without a bridge. I then ascended the opposite hill; and at three o'clock I arrived at *Catchfrench*, where I was received with the hospitality so prevalent throughout the whole county of *Cornwall*. Mr. Glanville, being acquainted with my object, was so good as to order dinner to be brought immediately, that we might have time afterwards to walk along the brow of his hill, which commands the deep valley wherein the *Seaton* flows.

1306. When we came to a part of this brow, whence we had on both sides a very extensive view of the bottom of the valley, which is very wide, I saw there only meadows, without any appearance of a *stream*. Mr. Glanville then pointed out to me what, though it seemed to be merely a double hedge-row following the foot of the opposite hill, is really the bed of the *river*, bordered with alders; and he  
told

e that the stream never rises above this bed, during long rains and sudden thaws. Proceeding then along the brow of the hill, we arrived at last to a wood, occupying a *combe* as wide, in every part, as the valley of the *Seaton*; and thus, Mr. Glanville said that scarcely any water issued, except during rainy seasons. As we resumed our walk on these hills towards the sea, I reached a point whence the valley, still at the same depth, after several windings, takes, almost in a straight line, its direction towards the sea; and Mr. Glanville told me that this part had formerly been a bay, in which the tides had ascended as far as *Wenford*, several miles from the coast; but the beach having been raised and extended, this bay has been filled up; and a bar of gravel accumulated at its entrance by the waves, all the ground within has been converted into meadows, through which the *Seaton* has prolonged its course, and now passes out to the sea on one side of the bar. The beach has extended itself so much, that, in some parts, it is, at low water, more than two miles inland; so that the waves no longer reach the shore on the coast, except near some capes, such as *Wenford head*, at the eastern extremity of the bay, which I described in the preceding journey.

7. After having given me this particular information concerning the valley of the small river, which was then within our view; Mr. Glanville told me that the case was nearly the same with

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respect

respect to the vallies of the two *Loocs*, before they meet, and extend united down to the same bay; their bottom being likewise covered with meadows, and their common æstuary almost entirely filled up: no bar of gravel is formed at its entrance, so that the tides still ascend in it a considerable way; but their sediments are continuing to heighten it, and the meadows to increase in extent towards the sea.

1808. I am thus returning to the borders of *Cornwall*, after having made the complete circuit of this peninsula, for the purpose of investigating the facts to which Mr. Playfair has referred, and on which he almost entirely rests a system that embraces nearly the whole of the history of the continents, and of the human race inhabiting them: this is, that vallies have been *excavated* by *running waters*, which have thus cut their own passage to the sea. In p.p. 368 and 369 of his work, he names several of the Cornish *rivers*, imagining that in them may be evidently recognized the certainty of his system: now in observing not only these *rivers*, but all the others which arrive at the sea in their intervals, I have not relied solely on my own judgment, with respect either to the certainty of the facts, or to their consequences; I have every where sought and obtained information from gentlemen of the country, well acquainted with all local circumstances, who indeed have frequently been my guides, and with whom I have examined Mr. Playfair's ideas, as has been seen the whole way. I there-

fore consider the following general result of these observations as resting on the most solid basis.

1309. I have every where found these gentlemen astonished how those, who believe *running waters* to have *excavated* the *vallies*, can have avoided seeing that, on the contrary, they have *raised* the *bottom* by their sediments. This fact is of so much importance in Geology, that I have not been afraid of multiplying examples with a view to its establishment, but have described these effects at every *height* on the Continent, this being one of the most essential circumstances of the phenomenon. Among those who support the above system, there cannot surely be any who have not *somewhere* seen vallies of which the bottom has been *raised* by the rivers flowing in them; but their prejudice has deceived them into the persuasion that such is not *generally* the case; and hence have arisen various illusions, of which an instance appears in the following passage of Mr. Playfair's work, p. 352, already cited in § 1026. "It requires but little study," he says, "to replace the parts removed, and to see nature at work, resolving the most hard and solid masses, by the continued influences of the sun and atmosphere. We see the beginning of that long journey, by which heavy bodies travel from the summit of the land to the bottom of the ocean, and we remain convinced, that, on our continents, there is no spot on which a river may not formerly have run. The view thus afforded of the opera-



tions, in their nascent state, which have shaped  
 out and fashioned the present surface of the land,  
 is necessary to prepare us for following them to  
 the utmost extent of their effects. From these  
 effects, the truth of the proposition, *that rivers*  
*have cut and formed, not the beds only, but the*  
*whole of the valleys, or rather system of valleys,*  
*through which they flow, is demonstrated on a*  
 principle which has a close affinity to that on  
 which chances are usually calculated." Proceed-  
 ing afterwards to apply this calculation of chances,  
 he says, p. 354, "Where the lake and the cataract  
 are comparatively rare phenomena, there we per-  
 ceive that constitution of a surface, which water  
 alone, of all physical agents, has a tendency to  
 produce; and we must conclude, that the pro-  
 bability of such a constitution having arisen from  
 another cause, is, to the probability of its having  
 arisen from the running of water, in such a pro-  
 portion as unity bears to a number infinitely  
 great. I shall presently shew that the error of  
 this calculation, very surprising in the theory de-  
 fended by Mr. Playfair, consists in his not allowing  
 for any other agents in the production of vallies,  
 than those which, since the continents have existed,  
 have exercised their action on them; but first I  
 shall make it evident, from what he says himself,  
 not only that there is no probability, but even that  
 there is an absolute impossibility, in the formation,  
 by running waters, of vallies, such as they actually  
 exist.

1310. After the foregoing passage, Mr. Playfair considers, under a general point of view, the fact which I have mentioned above; that, on the bottom of vallies, is found a quantity of materials, deposited there by *running waters*; and on this subject he says, p. 356; "There is often clear evidence, that "a *river* has run or stood much *lower*, because the "alluvial land reaches far *below* its *present level*. "This is known to hold in very many instances, "where it has happened, that pits have been sunk "to considerable depths on the banks of large rivers." And he accounts for such phenomena, by supposing *lakes* to have existed in these places, and to have been filled up with the materials brought down by the stream. Were then these *cavities* formed by the agent, which, as he conceives, has *cut through the rocks in the same way, and almost with the same instrument, as a lapidary divides a block of marble or of granite?* But it is evidently impossible that a saw can produce *partial hollows* in the line of its course; especially as, under the above supposition, such hollows must have existed at every *height*, since there are very deep *alluvial soils* in innumerable parts of the courses of *all rivers*, from their highest level among mountains till they descend to that of the sea. Mr. Playfair did not here perceive that he was overturning his own proposition, "that rivers "have *cut and formed*, not the *beds* only, but the "whole of the *valleys*, or rather system of vallies, "through which they flow;" since, in this case, a *river*, after having lowered its course by excavation  
down

down to a certain level, must have continued to cut and hollow out the rocks to a very great depth, in parts *where it did not flow*, that is to say, *below the level of its current*: which is manifestly a contradiction.

1511. Mr. Playfair, when he gave this explanation of the accumulation of materials on the bottom of *vallies*, with a view to reconcile this circumstance with the system of their *excavation* by *running waters*, against which it had formed an insuperable objection, forgot that, at the very beginning of his work, he had himself pointed out, in the situation of our *mineral strata*, the only possible cause of the formation of *vallies*; a cause which, at the same time, agrees with all their characters, and with every effect of running waters in them. I have said from the first, that I have chosen the Huttonian theory for the purpose of bringing forward to examination all the questions of which the decision is important to the history of the earth, because, in this theory, is acknowledged the great truth manifested by the progress of observation, that our *mineral strata*, after having been formed in a *horizontal* and *continuous* situation, have experienced very great catastrophes, whereby they have been reduced to the state in which we now see them. We are not to consider, in this place, how the *form* given by these catastrophes to the surface of our continents has been produced; that is to say, whether the *highest* parts of these continents (mountains and hills) have been *elevated*, or  
 their

their *lowest* parts (vallis and plains) have *sunk down*; the present question is solely this: what *form* must the *surface* of the continent have acquired by the effect of either of these changes in the original situation of the *mineral strata*? Now, the following are the terms in which Mr. Playfair expresses himself on this subject, p. 52, where he gives the summary of all that he has detailed respecting it from observation. "On the whole, therefore, by comparing the " *actual position* of the *strata*, their *erectness*, their " *curvature*, the *interruptions of their continuity*, " *and the transverse stratification* of the *secondary* " *in respect of the primary*, with the *regular and* " *level situation* which the same strata must have ori- " *ginally possessed*, we have a complete demonstra- " *tion of their having been disturbed, torn asunder,* " *and moved angularly.*"

1312. This exposition is very exact; but if these *angular motions* have taken place, is it not evident *that mountains and hills*, with the intermediate spaces, *must have immediately resulted from them*; since *the masses* which have undergone these *motions* do *themselves form chains of mountains*? In the winter, we see operations absolutely analogous to the *above*, on the sides of large rivers, such as the *Rhine* and the *Elbe*, when great frosts having formed on *them* a crust of ice many feet in thickness, a long continuance of dry weather has lowered the level of *the stream*; this crust then sinks in the middle; and being supported on the sides by the slopes of the banks,

banks, where it meets with ledges of rocks, and other masses, of different sizes, it breaks on these, and, falling down between them, assumes all kinds of forms. The great mouth of the *Elbe*, in particular, has afforded me a spectacle of this nature, in which, on a small scale, the *chains* of the *Alps*, with their *vallies* and their *peaks*, have been exactly represented; and in other parts of the banks, where the ice, in its subsidence, has met with props more regular and not so high, I have seen other chains resembling that of the *Jura*, with *plains* around them, and even *lakes* in the lowest parts, where broken pieces have sunk beneath the level of the water, leaving elevated laminæ around the cavities. It is only in great rivers, which, in their swells before frosts, occupy a large space, whence they retire during the succeeding dry weather, that models so complete as these, as well of the *Alps* as of smaller *mountains* and *hills*, can be observed; but effects of the same kind may be seen in many ponds, which rise in the rainy season, freeze at that high level, and are afterwards diminished by the filtration of the water into the ground. If in these ponds there are any little elevations whereon the ice breaks as it sinks, the scene which I have just described is produced in them, though all its features are proportionally smaller.

1313. The same changes of *relative level*, and the same *angular motions*, must have taken place, as I have often said, in the catastrophes of our *mineral strata*, whether occasioned by the *subsidence* of the  
parts

parts which are now the lowest, or by the *elevation* of those which are now the highest: and in either case, the present form of the surface of our continents must have been thus produced. It is on this account that I have so frequently described the *situation* of the *strata* in *hills* on the borders of *vallies*, whereof Mr. Glanville shewed me a new example in those which extend eastward, from the course of the *Seaton* to that of the *Tamer*, and are cultivated on a loose soil of little depth. He told me, that, were it not for the frequent rains on this part of the coast, these hills would yield nothing by cultivation; because the rain-waters, after having penetrated the above thin soil, flow immediately down between the *strata* of *schistus*, which are nearly *vertical*, or strongly inclined. After facts so general with respect to the situation of the *strata* in *hills* and *mountains*, what need is there, as a mode of accounting for the existence of their *vallies*, to have recourse to *running waters*, which are so evidently incapable of producing such effects? Especially when this system replunges into the abyss of past time, not only the origin of our lands, but that of the human race inhabiting them; while the small antiquity of these lands is proved by all the operations of the causes which really have acted on them,

*August 11th.* Mr. Glanville, who had taken great interest in the objects of our observations the preceding day, was so good as to accompany me on horseback some way on my road, in order to point out to

me the courses of the two last rivers of *Cornwall* on this side, the *Tidi*, and the *Lynher*, both entering æstuaries, which are much ramified by the lower parts of combes affording passage to brooks, and which, when united, form the æstuary called *Lynher creek*, a lateral branch of that of the *Tamer*.

1314. We set out at ten o'clock in the morning, and soon came to a quarry, from which was taken the *iron-stone* already mentioned. Mr. Glanville told me that masses of this are here and there found on these hills of so large a size that they are worked as quarries, being, nevertheless, insulated amidst *schistose* rubbish; a phenomenon similar to many which I have described with regard to stones of other kinds. This stone is very proper for walls, on account of its hardness, but it cannot be cut with the chisel; in this respect, it resembles what is called *etwan* in the country of the mines, which is generally found in *cross-courses*, but sometimes makes a part of the gangue of the *loads*, and then greatly increases the expense of working them. I was told by Mr. Stackhouse, that, in one of those mines where the work is done by the task, there is a shaft, in a part of which the excavation has cost 120l. the square fathom; because the stone, everywhere called *etwan*, though probably not in all places of the same origin, is there as hard as *flint*; so that, the tools being immediately blunted, and very often breaking, a very considerable expense was incurred for them, as well as by the time taken up in working; but the *load*  
could

could not be followed, without cutting through this mass. We stopped at the quarry which lay in our road, and Mr. Glauville inquired of the workmen what was the extent of the vein of *iron-stone*; they replied, that they knew not what might be its limit below, but that above, it extended a quarter of a mile farther in the same direction, and was then lost in the *schistus*.

1315, After this, we passed over a high hill, whence we had a view of some part of the systems of waters of the *Tidi* and the *Lynher*: both these rivers arrive from the north; and the latter has its origin on the eminences covered with peat, which I had crossed in my way from *Launceston* to *Bodmin*. Hence we descended to pass the *Tidi* at *Tidiford*, near the point where this stream arrives at the level of the sea, and issuing from a narrow passage between hills of considerable height, suddenly enters a very wide space, which is clearly seen to have been the head of a branch of the gulph, though it is now covered with meadows. The tides do not at present ascend so high as *Tidiford*; but advantage is still taken of them to bring up to a spot, a little below, the *Plymouth lime-stone*, with Welch *culm* to burn it into lime, which is used for agricultural purposes in the neighbouring country. The tide being then low, the vessels that had brought up these materials were lying on the mud.

1316. We next ascended a hill which separates  
the



the lower parts of the courses of the two rivers ; and we advanced on it to a spot whence we had a view of the junction of their æstuaries, both enclosed between high hills : this space was then dry ; and in the æstuary of the *Tidi*, we saw the little river flowing in the channel by which the tide had retreated. Mr. Glanville told me that it was the same with the *Lynher*, and with all the brooks entering the large space called *Lynher creek*, which, from its whole appearance, could not be ascribed to any other cause than the subsidence of a part of the *schistose strata* ; for this space and all its branches are filling up more and more by the sediments of the land-waters, but in a still greater degree by those of the tides.

1317. Here Mr. Glanville quitted me to return home, and I was very sorry to be obliged so soon to part with him. I then proceeded to *Landrake* ; and from this village, which is on the hill just mentioned, I descended to *Nottar bridge*, where the *Lynher* is crossed very near the point still reached by the tides, though that point is not seen from the bridge, because the æstuary winds between high hills. This is again a very remarkable space, forming a large basin, of which the bottom is covered with meadows, and into which there are three openings between the high hills : by one of these openings the *Lynher* enters it, and flows through the meadows ; by another, which, being the extremity of a *combe*, is quite as wide as the former, arrives only a brook ; and these waters, when united, issue forth by the third opening,

opening, and there pass out of sight. A little above the bridge, I saw one of the hills crossed by a projecting line of the *iron-stone*, which appears, therefore, still more probably, to be one of the *cross courses* passing through this part of the country. Ascending next a hill to the eastward, I had a view of a great extent of *Lynher creek*, covered with meadows, through which the small river winds; and having passed over this hill, I descended rapidly towards the little town of *Saltash*, situated on the lower parts of its slope. This is the part where the *Hamoaze*, or æstuary of the *Tamer*, is crossed; it being here narrowed by two opposite promontories; that of *Saltash* belongs to *Cornwall*, and separates *Lynher creek* on the south from the next creek on the north; but the other promontory which is called *Canterbury*, and likewise separates two æstuaries, belongs to *Devonshire*. Having staid a little while at *Saltash*, it was high water when I crossed here; so that the lower parts of all the lateral æstuaries were filled, and the upper part of the *Hamoaze* resembled a fine lake surrounded with hills, the branches of which, descending with a gentle slope, indented the borders with many small capes covered with verdure. As in my former journey I have spoken of the beautiful scene which here opens towards the gulph of *Plymouth*, I shall not now stop to describe it. At three o'clock I arrived at *Plymouth*, where I went to the house of my friend Mr. Gandy.

*August 12th.* I spent this day at *Plymouth*; for  
after

after my long excursion, I was glad to rest myself in this worthy family. However, I went to the Dockyard, to pay my respects to Admiral YOUNG, and to the Commissioner and Mrs. FANSHAWE, whose amiable daughter, Mrs. Glanville, I had just quitted. I availed myself of these opportunities of conversing on the objects which I had observed during my tour, that I might judge whether I had accurately viewed them.

*August 13th.* At half past ten in the morning, I set out from *Plymouth* for *Exeter*, with the intention of crossing, near their origin, those rivers of which I had observed the mouths on the southern coast of *Devonshire*. I did not, however, ascend the *Plym* any higher than I had done in my preceding journey: I again crossed it at *Newbridge*, at the extremity of its æstuary; and I then followed, within Lord BORINGDON'S park, the small stream, which, as I before mentioned, joins this river below the bridge, after flowing through meadows formed on the soil filling up an ancient lateral æstuary, now secured by a dike against the return of the high tides.

1318. Hence I proceeded to the house of Mr. HAYNE, a clergyman at *Plympton St. Mary*, whom I had met at *Ashfield*, while he was on a visit to his friends in the neighbourhood of *Honiton*; at which place he formerly resided, and is much loved and esteemed by those who were then acquainted with  
him.

him. I wished, through him, to obtain precise details respecting the progress of the filling up of the æstuary of the *Plym*, which is bordered on the east, by the grounds of *Saltram*; and these he has since procured for me from the most authentic source, having applied, for this purpose, to the steward of the estate. Lord Boringdon, being much engaged in agricultural pursuits, has availed himself of the advantages afforded by the retreat of the sea in this æstuary. In 1797, he enclosed in the *Catwater* a space, in which was constructed a dry dock, fit for the repair of ships of 64 guns; slips were afterwards formed in it for building ships of the line; and two of 74 guns were laid down here in 1809. In 1806, he began the construction of an embankment for the enclosure of a creek in the æstuary, called the *Lower Lary*, containing a space of 175 acres. This imbankment was completed the following year, and much has since been done for the amelioration of the enclosed soil, which has been attended with much difficulty, on account of the quantity of marine salt contained in the mud. However, as the tides have no longer access to this space, means have been found of delivering it from the salt, by overflowing it with the land-waters, which, after having lain on it for some time, are allowed to pass off when the tide is out, and also by spreading lime over it; nor is any doubt entertained of the conversion of this soil into meadow-land. It is likewise Lord Boringdon who has enclosed at *Charleton*, in the gulph of *Salcombe*, that space of 40 acres which

I men-

I mentioned in my former journey: besides this, he has planted with trees 300 acres, hitherto, in general, producing nothing but furze; and lastly, in a narrow part of the æstuary of the *Plym*, he has built a *flying bridge*, by which carts and carriages can now pass to *Plymouth*, without being obliged to go round the æstuary, and over the hills.

1519. On my quitting *Plympton*, Mr. Hayne and Colonel ARCHER were so good as to accompany me to the top of the next hill, in order to point out to me many parts of this spot, interesting in themselves, though not very essential to be mentioned, as they would only be repetitions of what I have elsewhere described. Beyond this, the first river to which I came in the road, was the *Yealm*, whereof I had seen the æstuary at *Yealmpton*. All this country is intersected with *combes* directed towards the principal vales; and when, coming to that of the *Yealm*, I crossed the stream, at *Lee mill*, I saw it flowing on a bed covered with rounded fragments of stones of various species, which are taken hence to gravel the roads. These fragments cannot be ascribed to the action of the river, as attacking the rocks, for many of the same kind are scattered on the hills, which slope down to its bed with a gentle declivity: when it overflows, it attacks in some parts the foot of these hills, carries the earthy particles thus detached from them down to its æstuary, and rolls along, on those parts of its bed where it flows rapidly, the stony fragments mixed with these particles;

particles; which operations will be continued, till the river shall have so much widened these spaces, as no longer to attack its banks.

1920. Crossing the hill beyond the *Yealm*, I found its opposite slope directed towards the *Erme*; of which I had seen the æstuary at *Muddicombe*. The road on this side is no longer covered with the gravel of the *Yealm*, but with fragments of *grey wacke*; and *strata* of the same stone, much disordered, appear at the surface, inclining inwards. *Ivybridge*, where the *Erme* is passed, is a place much celebrated in this county for its picturesque scenery, for which a traveller is prepared by the abundance of *granitic blocks* scattered on the slopes of the hills. The river is here seen precipitating itself, under the bridge, into a deep cleft in the *strata* of *grey wacke*, studded with pointed rocks of the same kind; and rushing among large blocks of granite, which cause it to foam and roar along all this part of its course. Those, who believe the *blocks* of stone scattered over so many parts of our continents to have been transported thither by rivers, might very well suppose, if they passed this way without observing the neighbouring grounds, that the *Erme* had brought down hither some of the masses of *granite* from *Dartmoor*; but when I ascended the river above the cataract, I saw it calmly flowing between the feet of two woody hills; the bottom of its bed was formed by the edges of *strata* of *grey wacke*, strongly inclined inwards; which indicates the cause of the formation of the

valley. On this bed were some *blocks of granite*, and smaller fragments of the same stone, as is the case on the neighbouring slopes; the water was perfectly clear, and I saw all these stones *covered with moss*; a proof that they are not moved by the stream. This is a very common case, though it has not been remarked by those who believe that the rivers are continually *deepening* the vallies; streams do not really exercise on their bottom any sensible action, as they flow only at their surface, and to a certain depth below it; so that, except on very rapid slopes, where they do not deposite their sediments in sufficient abundance, their bed is covered with aquatic plants.

1321. I ascended the hill beyond the *Erme*, and after but little descent on the opposite side, I passed, at *Bidiford*, a small stream which discharges itself into the æstuary of the above river. I afterwards crossed a deeper valley, where, however, the stream is too inconsiderable to require a bridge, being carried in a little channel under the road. This valley, which bends to join that of the *Erme*, separates the cultivated hills whereon I was travelling, from the low uncultivated ridges of the foot of *Dartmoor*.

1322. I came next to the *Aven*, of which I had seen the æstuary at *Bentham* and *Bigbury*; and I passed it at *Blackhall*, in a very deep valley, the bottom of which is so wide, that this river appears in it to be  
nothing

nothing more than a brook flowing calmly over a bed of stones covered with moss. I expected to have met with another stream between the *Aven* and the *Dart*, because, in my former journey, I had observed between *Avenmouth* and *Dartmouth* a vast æstuary, at the entrance of which from the sea are *Salcomb* on the west, and *Portlemouth* on the east: but I learnt that the small stream entering this æstuary at *Kingsbridge* has its origin in combes nearer to the sea than the road along which I was now travelling.

1323. In this road from *Plymouth*, where the *schistose* hills over which it passes are all scattered with *blocks* of *granite*, there is a proof that the latter have not been transported hither from *Dartmoor*, though its eminences, covered with *blocks* of the same kind, are seen at but little distance on the north; this proof is, that, except in a small space between the *Yealm* and the *Erme*, where the *schistose* hills rise directly towards those eminences, they are separated from them by a deep vale, which follows the foot of *Dartmoor*, and in which, if any *blocks* had been brought down from the latter, they must inevitably have been stopped. The rills of water descending from the *combes* of *Dartmoor* arrive first in this vale, where, instead of deepening it, they deposit whatever they have brought along with them: hence continuing their course, they enter some intervals between the *schistose* hills, and form the beginnings of all the small rivers above described.



1324. After having crossed the valley of the *Aven*, and reached the farther side of the hill forming its eastern boundary, I came to the western part of the system of waters of the *Dart*, and passed at *Lec bridge* the same branch of that river which I had crossed between *Dartmouth* and *Bowden*, and which proceeds by *Cornworthy* to discharge itself into the æstuary of the *Dart* below *Totness*. I went on to that town, where, in my former journey, I described the prospect commanded by its bridge, of the large basin, covered with meadows, in which a multitude of rivulets discharge their waters into the *Dart*, and whence that river arrives to pass under this bridge. I spent the night at *Totness*.

*August 14th.* I set out from this place at eight o'clock in the morning, in order to return to *Teignmouth*, going first towards *Babicombe bay*, as I wished to observe a part of it which I had not had an opportunity of seeing in my former journey. After having passed the bridge at *Totness*, I took a road leading over the hills to *Berry Pomeroy*; and the weather being very fine, I was induced to ascend an eminence near that village, which I have never seen, except in the *Alps*, a *Panorama* more worthy of the talents of the inventor of that astonishing kind of circular picture, (Mr. BANKER,) whose representation of Mount Edgcombe I had formerly admired; but here the scene was grander and more varied. The horizon was on all sides bounded by the sky: on the S. E. I saw the sea beyond *Torbay*; on the north,

north, appeared a great extent of the chain of *Dartmoor*, some parts of which were near enough to present interesting details; on the other sides, the line of the horizon was broken by the sinuosities of smaller eminences; and within this frame was enclosed a most beautiful landscape, above which I was so much raised as to perceive here and there, between rich and fertile hills, the courses of many of the rivers heretofore described, and especially of the *Dart*. I am not acquainted with any space of equal extent, wherein, when the particular objects are known from preliminary observations, a single glance may command a greater number of monuments of the catastrophes, which have brought to the same level many different kinds of *strata* originally deposited one on another, and by which *vallies* have thus been produced between the *eminences*; whereof new instances will be seen in *Babicomb bay*.

1325. When I came to the great cape forming the separation between this bay and *Torbay*, I went on towards *Marychurch*; and after I had crossed a slight inflexion in the hill, I perceived that I was no longer on the *schisti*, over which I had so far travelled, but on *lime-stone*, of the kind described in my former journey; where I said that the masses of the broken *strata*, dipping inwards, raise their summits in rocks above the grass. I proceeded along the top of the cliffs bordering the bay, till I came to the eastern side of a large *combe*, at the bottom of which is the village of *Babicomb*; this village, having been

*strata* are abruptly cut down towards and on the side by which I ascended to the brow, their section forms the surface of a rapid slope. I alighted from my chaise, proceeded along the brow of the precipice immediately above the cove, whence I saw at the level of the beach on the side opposite and under the section of the *red strata*, the *strata*, which appeared to me to consist of *stone*, and which may probably have been of those *calcareous* masses that I had seen with Mr. Short, in the *red strata* forming at *Teignmouth*, (§ 1019); where the *strata lime-stone* are undoubtedly at a lower level do not appear. In the sea, before *Crane* is a rock of *red strata*, which I supposed the same distinguished in the map by the name *rock*, and of which the base consists of forming that of the neighbouring cliff or *site side*. From the high point whence this cove, I could already discover the *Ermouth*; and though the ground is lowered towards that gulph, many *combs* ascending to the sea, lie in the intermediate one of these *combes* is that of *Daxlish*, well described in the former part of this journal.

1326. I arrived at the gulph of *Erm* place called *Cockwood*, whence I proceeded its western side, where I saw coming down water many ridges of hills, between which

had been lateral *creeks*, now changed into  
 rivers: I crossed one of considerable breadth on  
 a bankment, with a sluice to carry off the land-  
 water whereby its meadows have been drained.  
 I came to *Starcross*, a small port in a creek  
 through which a brook discharges itself. At this place  
 is a vast extent of meadows belonging to *Pow-  
 ell*, a fine seat belonging to Lord COURTNEY;  
 with whose permission, the border of the gulph may  
 be followed by a very pleasant road on the im-  
 ment which encloses these meadows, and in  
 there are several sluices for the discharge of  
 the high-waters. At the point where the village of  
*Exminster* is situated, the hills on the opposite  
 of the gulph approach each other; I crossed  
 between their branches on this western side, in my  
 way to *Exminster*; and as they have here been cut  
 to a considerable depth, in order to soften the  
 hardness of the road, the *strata* thus discovered  
 will not reason to attribute the dissection of the hills  
 to the brooks formed in their combs: these are the  
*strata*, alternately soft and stony, but always  
 more or less intermixed with strata of *breccia*; and  
 are *inclined* in various directions, according to  
 the situation of their several masses. The extremi-  
 ties of these branches were originally promontories  
 in the gulph, and some separated masses, lying in  
 the same direction, formed islands in the water; but  
 in the intervals, being now filled up, are covered  
 with meadows. At seven in the evening I arrived at  
*Exminster*,

*Exeter*, where the bishop was so good as to lodge me in the palace.

*August 16th and 17th* were for me very pleasant days of rest; and on the latter, in the afternoon, Archdeacon FISHER, one of the bishop's brothers, walked with me, through meadows, to *Cowley bridge*, two miles from *Exeter*, in order to give me a first view of the course of the *Ex* above that city. These meadows form a vast basin, surrounded by hills, which exhibit the most characteristic marks of their own formation, as well as that of the basin, by *subsidence*. I have said on a former occasion that *Exeter* is built on the slope of a hill composed of the *red strata*, and extending southwards down the gulph as far as *Topsham*. On the north of the city, this hill forms one side of a deep combe, which rises behind the pleasant walk bordered with trees, called the *Northernhay*; and here we went down by steps to the river-side. Now in the lower part of this *combe*, rocks of *schistus* prevail within a certain space, and their *strata*, in great disorder, are seen to change their respective levels and inclinations on the opposite sides of their numerous fractures; but higher up the river, these are succeeded, at the same level, by the *red strata*.

1327. The *Ex* flows through the meadows of this basin, after having received the *Creechy* and the *Culm*, which arrive by two valleys, the former from the N. W. and the latter from the N. E. My principal

principal object had been to observe the base of the soil of these meadows ; and for this an opportunity is afforded by their intersections, as well natural as artificial. The principal natural intersection here is the channel preserved through the meadows by the *Er*, in which the water was then so low, that at one point we crossed it on foot on the gravel covering its bed; thus the section of the soil was on both sides exposed to view. Of the artificial intersections, one of the greatest is that which serves to lead a part of the river along the foot of the hills, for the supply of a mill near *Exeter*; and we saw another begun, it being intended to extend the inland navigation from *Exeter* up to *Tiverton*, by a canal with some sluices. Now the sections of the soil on the sides of these various channels are a kind of archives, in which may be read the history of all the streams contributing to form the *Er*, from the time when they began to flow. The rain-waters, having first cleared the channels which they followed in the inflections of the surface from the top of the eminences down to their foot, drove before them the rubbish produced by the catastrophes of the strata, and deposited it in the lower vallies ; whence it has been successively brought down by the rivers, during floods, into this extensive space, where, losing their rapidity, they have only spread it over the original soil, as very plainly appears in all these channels. But the torrents, as they cleared their beds, found less and less *gravel* to propel before them ; and when vegetation was spread over the hills, the rills  
formed

formed immediately by the rain-waters washed down a successively smaller quantity of earthy particles and minute rubbish ; so that at last these various streams brought nothing along with them but mere dust. This may be clearly seen in the sections of the soil on the sides of all these channels ; the *gravel* diminishes in size from the bottom upwards, and is succeeded by particles gradually more and more minute, up to the surface.

1328. Thus the *Er.* when it overflows, no longer carries with it any *gravel* but that either spread on its bed by its first operations, or contained in the soil of the bordering hills, of which, at some points, it still attacks the foot : in common seasons, it flows at such a depth in its channel, that it must swell very considerably before it can rise above its banks ; but then, though the declivity is so small, the pressure of the waters above gives it sufficient rapidity to roll along the gravel on the bed of its narrow channel down to a part below *Exeter*, where, having room to spread, it deposits this gravel, which is taken thence, for various purposes, when the water is low.

1329. The navigable canal here begun is cut down deep enough to shew the original soil on which the gravel was at first deposited. In a spot near *Cowley bridge*, where the hill descends with a gentle declivity under the *alluvial soil*, the latter being pierced through, the *red strata* appear ; and beneath these,

these, in another part where the slope of the hill is more rapid, have been found *strata* of *schistus*. The *schistose strata* are here very much inclined; whence it is evident that they must have been subjected to catastrophes before the *red strata* were formed upon them; but they afterwards underwent, together with the latter, a new catastrophe, at the time of the *subsidence* by which the large basin was produced. Of these effects, the impression manifestly appears in all the surrounding hills; as will be seen by particular descriptions of them in a second visit; that I made to this place a few days afterwards, when I observed new proofs of the recency of the epoch at which the land-waters began to pass through this space in their way to the present sea.

• *August 18th.* The Bishop was the next day to hold a confirmation at *Moreton Hampstead*, a small town on the confines of *Dartmoor*, through which I had passed with Mr. Hill in my way into *Cornwall*: Mrs. Fisher was also going there, with her two daughters, and their governess, Miss Tuffnell; and the Archdeacon, who was to accompany the Bishop, was so good as to take me with him in his chaise.

1330: Having gone down the principal street of *Exeter* to the great bridge over the river, which we there crossed, we came to a long causeway, with houses on both sides, forming the road through the meadows towards the opposite hills. There I learnt that



the parsonage house, where we went to alight. As I was in the suite of the Bishop, Mr. W. CLARKE, the clergyman, received me very civilly, and lodged me in his house with the rest of the party.

*August 19th.* This being the day appointed by the Bishop for the confirmation of the young persons of this parish, and several others in the neighbourhood, a brother of Mr. Clarke offered to accompany Mrs. Fisher, the rest of the ladies, and myself, as our guide to *Beckey fall*, a spot very curious in many respects.

1333. From *Moreton Hampstead* we took our road along the borders of this side of *Dartmoor*, which is terminated on the south by the large rock of granite called *Heytor*, seen from a great distance all around. This is the side that is turned towards the valley in which the *Teign*, arriving from the west, bends its course towards the south; being the same side that I had viewed from a distance with Mr. Hill, when he had pointed out to me on it the trace of a vale, obliquely descending its slope, through which the *Bovey* flows in its way to join the *Teign*. We first passed the *Wrey*, in the upper part of its vale, and afterwards, several streams that join the *Bovey* half way down the slope, while the *Wrey*, as I said before, has found a wide channel which leads it directly to the bottom of the valley: all these streams proceed from the *peat-grounds* of *Dartmoor*. We passed the *Bovey* in a high part of its course, at  
*North*

*North Bovey*; then, beyond *Manaton*, we entered the lower part of a very wide *combe*, descending from the west, and terminating at the brow of the great and rapid slope of which I am speaking: at the bottom of this *combe*, here horizontal, is a large marshy space, whence issue two rivulets, both of which rush precipitately down the slope; they unite upon it, and then, under the name of the *Hayne*, proceed to join the *Bovey*. The southernmost of these two rivulets forms the beautiful cataract called *Beckey fall*; and we crossed them both in the upper part of their course.

1334. The southern part of the *combe* just mentioned advances in a promontory above the rapid slope; and by a great excavation in the side of this promontory which turns towards *Beckey fall*, a horizontal space has been obtained, of a sufficient size for the erection of a farm-house. Now, in the ground thus opened to a considerable depth appears nothing but loose *growan*, mingled with *blocks of granite*; such being also the nature of the whole of this vast and rapid slope of *Dartmoor*, which forms the western side of the valley of the *Teign*, and which, for this reason, is covered with woods, inasmuch as no other product can be obtained from it, except the little grass growing between the *blocks*, and serving as pasturage for cattle. We proceeded with some difficulty through the woods on this slope, till we came down to the foot of the cataract; the roaring of which, at the time of the melting of the

snows, is heard, with certain winds, as Mr. Clarke told us, at the distance of three miles : it was not very considerable when we viewed it, as there had been no rain for some days ; but it was rather the more beautiful on that account.

1335. On viewing here the immense quantity of *blocks*, which, lying one under another, seem themselves to form a cataract, those who believe that torrents destroy mountains, and at last reduce them to the level of the plains, might be led to suppose that these *blocks* had been brought down by the stream ; but they would soon be undeceived, if they considered with a little attention the surrounding objects. Were such the case, we ought at least to find, on the bed of the stream above, other *blocks* in their way hither ; whereas this stream issues, as I have said, from a horizontal and marshy space, and has no rapidity till it begins to precipitate itself from the brow of the slope. This, therefore, is only another example of a case described § 1051, on the slope of these same mountains bordering the *Dart*, namely, that the stream, by washing away the *growan* which originally filled up the intervals of the *blocks*, has left the latter uncovered : and a proof that they do not migrate is that they are overspread with moss. At the time when we arrived there, this moss was interspersed with little flowers, which, with the large trees bordering the cataract, contributed to embellish the scene ; where a limpid stream was seen first to precipitate itself from above, and for some way to  
bound

ound divided from block to block; often disappearing between them, and again issuing forth in several rills, which glided along their mossy surface, falling from some of them in a sheet of water, with the alternate glittering and transparency of a silver gauze: but this sheet was soon lost among the blocks; whence the stream repeatedly burst forth, and afterwards, flowing calmly for some way, rushed precipitately down another slope. Mr. Clarke had taken care to provide for us a collation, which was spread out on a large block covered with moss; but, as the cataract was accessible at various points, we each took our morsel in our hands, and advanced separately, climbing over the blocks, where we drank of the small rills of water trickling from the moss. This scene, which was rendered still more picturesque by a bright sunshine, was sketched from below by one of the party.

1836. An explanation of what is here observed is afforded by the whole surface of this slope of *Dartmoor*, as far as we had an opportunity of examining it; there is no part of this slope where a stream arriving from above, tearing away the grass, washing down the *growan*, and leaving the *blocks* naked, would not produce a spectacle of the same kind. Such was the judgment which I formed here; and Mr. Clarke, who was accustomed to shoot in these woods during the season for woodcocks, confirmed this idea by his own repeated observations: he told me that all the rills of water arriving on this slope

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produce,

produce, more or less, the same effect, except where they disappear from sight, and flow beneath the *blocks*. This is the case with the other stream, which unites with that of *Beckey fall* to form the *Hayne*, and which we had also passed above : I learnt from Mr. Clarke, that, when it arrives on the slope, it disappears among the *blocks*, and is only heard to murmur under them in various parts. It would take up too much time, were I to describe all the spots which I had an opportunity of observing in this excursion, and which shew with equal clearness how little, since the birth of the continents, their external form has been changed by *running waters* ; in fact, these have brought down from the heights nothing more than what, being collected in the horizontal spaces which have occurred in their course, there composes the *alluvial soils* now covered with meadows ; and the soils of this kind in the interior parts of *Dartmoor* consist of the loose *growan*, which has not perceptibly been carried beyond the vallies of these mountains.

1337. As we were on our return in the evening from *Moreton Hampstead*, I had a different view of this part of *Dartmoor*, and could more easily observe the course of this branch of the *Teign*, above the bridge by which we were again to pass it : at this point, where, arriving from the west, it turns to the south, its valley opens into a large basin, covered with meadows, and surrounded with ridges of hills, which advance on both sides towards the spot  
 where

where the bridge is built. Hence the river flows along the foot of the hills on its right bank; and these hills, like those just described as forming their continuation towards the south, are covered from top to bottom with *blocks* of *granite*. These *blocks* also lie on *growan*; and in many parts of the road along which we were travelling, we could see that the latter covered *strata* of *grey wacke*, or *dunstone*.

1338. All this day, we enjoyed the finest weather possible; however, on our return, as we were passing over eminences which commanded a very extensive view to the east, we saw on the horizon all the appearances of a great storm: large black clouds, by their rapid changes of form, assumed a resemblance to the smoke of an immense conflagration; this resemblance was increased by the vivid flashes of lightning which frequently darted through them; but the storm was too distant for the thunder to be heard. We did not doubt that there was in that direction some very extraordinary weather, though around ourselves the atmosphere was perfectly serene; and, in fact, we learnt afterwards at *Exeter*, that there had been over the *Blackdown hills*, and throughout a great extent of country to the eastward, a violent hurricane, accompanied with hail, thunder, and a deluge of rain. I shall not cease to repeat, so long as chemists continue regardless of what I have elsewhere said on this subject, that, until they shall direct their attention to the atmosphere, and endeavour to ac-

count

count for these phenomena, not by arbitrary hypotheses, but by intelligible causes, their general theories will remain without any solidity,

1339. On our return to *Exeter*, I had the pleasure of finding, at the Bishop's, Mr. Short and Mr. Oxnam, the patient companions of my first visit to *Babicombe bay*, when I had so much retarded their pace, being myself incumbered with the weight of nearly fourscore years: these gentlemen were at the palace with Mrs. Oxnam, her father, Chancellor NUTCOMBE, and her sister Miss Nutcombe; in the company of this very estimable family and that of the Bishop, I spent a most agreeable evening.

*August 20th.* In the first excursion that I had made with Archdeacon Fisher along the course of the *Ex*, above *Exeter*, my chief object had been the soil of the meadows through which the river flows; but I was also desirous to observe the hills surrounding this large basin; and he was this day so good as to take me round them in his chaise.

1340. In ascending the course of the river, as we passed over the hills on its left bank, we had a view of that great extent of meadows, together with the hills on the opposite side; and though between the latter flow only a few brooks, their intervals are as wide as that affording a passage to the river *Creedy*, above *Cowley-bridge*. This bridge is a kind of long causeway across the meadows, at the point where  
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the *Ex* (which passed under one of its arches, since destroyed by a flood) enters the large basin. We here met with some country people, of whom we made inquiries respecting the course of the *Ex* above this point; and they gave us the following information. The valley, of which we here saw the opening, extends up to *Tiverton*, at the distance of 10 miles: its bottom, in many parts very wide, is everywhere covered with meadows; and the inconsiderableness of its slope has suggested the project of making a navigable canal from *Exeter* to *Tiverton*. It is only at the latter place that the grounds, whence proceed the first branches of the *Ex*, begin to rise towards the eminences of *Exmoor*, which is of less extent than *Dartmoor*, but being, in the same manner, covered with *peat*, it has, on that account, this analogous name; and as it is situated very near the coast to the north, no waters issue from it on that side but some brooks, which discharge themselves immediately into the sea. The *Ex* is the only river that rises on these eminences, and it flows towards the south: its first branch bears this name, before it quits the heights; and another of its principal branches, which sets out in a westerly direction, joins the former above *Dulverton*. Two other small rivers unite also with the *Ex*, as I have already said, before it reaches *Cowley-bridge*; the *Culm* arriving from the N. E. falls into it some way above, and the *Credy* from the N. W. enters it very near that bridge.



1341. Having crossed over to the right bank of the *Ex*, we entered the grounds of Mr. JACKSON, who has a seat near the bridge, and we followed the river by a very pretty road cut through a wood; we there met with a farmer, who led us to the point where the *Creedy* joins the *Ex*, and whence they flow together along the foot of the hill; no precautions are necessary to prevent the river from attacking this hill, though the wood descends down to its border; because, when it overflows, it finds room to spread over its extensive tract of meadows. Wherever I could discover the *strata* of *schistus* on the slopes of the hills, I saw them inclined different ways, and in different degrees, on the opposite sides of their intersections; a proof that these hills are only the masses of the fractured *strata* which remained at the highest level, in the catastrophe whence resulted the large basin, with the vallies and combes that open into it. I am not afraid of repeating the same remarks in so many different places, because I wish to fix the attention of my readers every where on this object; in order that the idea of the excavation of vallies by running waters, which has so long prevailed in pretended *Histories* of the earth, may at last be banished from Geology.

1342. Descending again into the meadows, we found there the same farmer who had been our guide, employed, with three labourers, in cutting a wide and deep channel for a rivulet, and throwing out the earth without any order on its edge; which  
 appearing

appearing to be an unnecessary labour, as this little stream had already a channel of its own, I asked the farmer what was his motive for it: he then made me observe, in that meadow, some parts below the general level; and he told me that, when the river retired after floods, these parts were left filled with water, which evaporated but slowly; so that nothing grew there but rushes, and other herbage not good for hay: he had therefore a double view in cutting a new bed for the rivulet, down to the gravel, and making it very wide; that of lowering the level of the waters within this space, and of carrying the earth thus dug out to those lower parts of the meadow, in order to promote the growth of good grass there. I have observed similar low parts in other spaces of this nature, where the currents, during floods, not following the direction of the common bed of the river, but being turned by projections of the borders of the space, divide into several streams, which, at certain points, intersect each other. Wherever there are such changes of direction in a stream, its sediments are unequally deposited; for these are the least abundant at the points where the rills thus cross; and when the whole space comes to be covered with grass, the inequalities thus produced in it cannot be repaired by succeeding floods. Such was the inconvenience which it was the farmer's object to remedy; and this is a new example of what I have also pointed out elsewhere under various forms; that, when the operations of natural causes have made a sufficient progress to invite men to profit by their effects,

fects, human industry is then employed to accelerate or direct them, and to secure the advantages which may arise from them. In my first geological work, I have traced, with many details, from the mountains, through the plains, and down to the sea-shores, the various kinds of labour by which those who inhabit the borders of rivers, secure and improve the soils abandoned by the waters; and I have everywhere shewn the truth of that observation of M. DE DOLOMIEU, that "no great number of ages can have elapsed, since *our continents have been given up to the industry of man.*" As we continued our road towards *Exeter* over the heights bordering this western side of the meadows, we found the hills, consisting of *schistus*, divided by great intervals, in which, however, no water flows, because they are only *combes*; then, after passing over but a slight inflexion of the surface, we found ourselves on the hills of the *red strata*. Hence we returned to *Exeter* by the suburb of *St. Thomas's*, which, as I have mentioned, is built across the meadows,

*August 21st.*—At noon this day, I set out from *Exeter* for *Ashfield*, at the distance of 16 miles. I first ascended to the top of the hill on which *Exeter* stands; and after travelling some way in the direction of the *Ex*, I came down, by a long descent, to the level of the spacious meadows formed on the sediments of that river and the *Clyst*, which unite immediately below the small town of *Topsham*, situated on the extremity of the cape formed by this  
hill;

hill ; a space already described in my former journey. This long hill is covered with a prodigious abundance of the same gravel of *grey wacke*, which, as I then said, forms, at various depths, *strata of pudding-stone*, between other strata wherein no gravel is contained.

1643. At *Honiton's Clyst*, I crossed the small river which gives its name to that village, and to several others on its course ; and having passed over the meadows of this stream, I ascended a higher ground, consisting also of *red strata*, but differing in their nature from the preceding ; and here I found some of the same kind that I had observed in the cliffs at *Daxlish*, very remarkable as being divided into compartments by blackish veins of a harder substance, and, in the above cliffs, reduced by the actions of the air to the appearance of pigeon-holes ; the ground here continuing to be covered with the gravel of *grey wacke*. *Strata* thus easily recognized by distinct characters, when found in various places at different levels, with great intersections in the intermediate lands, (whereof I have given several other examples,) shew that the catastrophes which have thus broken and disordered them have been produced by different degrees of *subsidence*. These singular *strata* disappear in some parts, being covered with a greyish soil ; then other masses of them are seen, of which the intervals are filled with gravel of *grey wacke* ; as I saw in several places, where it was taken out to mend the road.

1344. I next ascended a higher ridge, called *Straitway-head*, which separates the system of waters of the *Ex*, from that belonging to the *Otter*; and here I found a great change in the surface of the country. The vale lying below this ridge on the eastern side divides the hills consisting of *red strata* covered with *grey wacke*, from the *Blackdown hills*, which, as I have said, like those of *Haldon* on the west of the *Ex*, have their surface covered with large masses of flint, on *strata* of *greyish sand* and *sand-stone*. The small river *Tale* winds through the meadows of this vale, in its way to join the *Otter*, which arrives through a wide interval between different ridges of hills, leaving that of the *Blackdowns* on the north. From the top of *Straightway head*, I saw, beyond this interval, the ridge of *Gittisham hill*, separating the system of the *Otter*, from that of the *Sid* to the eastward. I passed the *Tale* in its meadows at *Fairmile*; then the *Otter*, and a small stream which joins it, at *Fenny bridges*. The *Otter* being here divided in its meadows into various branches, four bridges were formerly required in this spot; but, when I passed it, I saw a canal begun for the purpose of uniting these branches under two bridges; which plan has at last been effected, though at first it was attended with some accidents.

1345. Although these rivers no longer commit such ravages as they formerly did, they still, in some places, attack the foot of the hills when they overflow. I was told by Mr. Luther Elliott, whom I mentioned

tioned before as having informed me of various particulars respecting the course of the *Otter*, that this river, during one of its inundations, covered a meadow belonging to him with an immense quantity of gravel. The cause of the continuance of these accidents is in general, that the opposite sides of a river belong to different proprietors; on which account its course cannot be straitened, nor its waters prevented from attacking some parts of its border. About a mile below *Honiton*, the *Otter*, formerly attacked a projecting part of its left bank, which it reduced into a small cliff; but by degrees, the gravel, crumbling down, removed the river to some distance from the part first attacked, which now forms a talus covered with grass: the stream, however, continued to excavate farther down, where the nature of the *strata* is seen in their section: they are the *red strata*, alternately hard and soft as in other places; and both by their ruptures and inclination, they indicate the subsidence which has produced the valley. As the excavation on that side was likely to proceed much farther, the owner of the land has planted piles, interwoven with twigs, to secure it against the attacks of the river, which is thus thrown across an alluvial soil, against the opposite side: the water was very low, when I observed the latter spot, so that there also I could see the history of this soil in the section of the side of the channel: at the bottom lies the flinty gravel which here covers the hills and their slopes; this diminishes gradually in size; and it is evidently seen that, for a long time, the river has deposited

deposited nothing but earthy particles, as is the case at present with all rivers during their inundations; nor would they now carry along with them even these particles, were it not that they still attack some parts of their borders, over which, for that reason, vegetation has not yet been able to spread.

1346. The art of putting a stop to the waste still committed by running waters, in plains as well as in vallies, is at present very well understood; but, in most cases, the interests of individuals prevent its being carried into effect. This art consists in cutting, through the alluvial soils, during a dry season, a deep and strait channel, from which, till it is extended to a sufficient length, the river is excluded; it is then suddenly opened, at a time when the stream is swelled; and the latter, rushing into it with impetuosity, completes the works, by continuing to cut its own way in the direction thus given to its current. But the courses of rivers often form the boundary between provinces and estates; and without some fortunate concurrence of circumstances, the inhabitants of their borders are continually doing injury to one another, each endeavouring to throw back the river to the opposite side. About sixty years ago, I saw two great projects of this nature successfully executed by the genius and known character of a single man; one relating to the *Tesin*, in the part where it separates the *Milanese* from the states of the King of Sardinia, and the other to the *Po* in the latter states. During a long time, the sovereigns on both sides

sides of the *Tesin* had repeatedly appointed commissioners to form a strait channel for that river, and put a stop to its devastations on both its banks; but these attempts had always proved unsuccessful, on account of the disagreements between the respective commissioners, who were professional men; when a friend of mine, Mr. MATTHEY of *Valorbe*, who was inspector of mechanics in the states of the King of Sardinia, and had drawn up a memorial on the subject, advised that prince, whose confidence he had gained by his talents and integrity, to write himself to the emperor, transmitting to him this memorial, and inviting him to appoint on his side a confidential person, invested with full powers, as M. Matthey should be on the other. The emperor consenting, every thing was easily settled with regard to the indemnifications to be made to the state which was to be the greatest loser by the new channel formed for the river; and the work having been entirely conducted by M. Matthey, a stop was put to the perpetual changes of the bed of the *Tesin* in its inundations.

1347. The same plan was afterwards pursued with respect to the *Po* in *Piedmont*: M. Matthey having, with the king's approbation, formed a plan to straiten the course of that river through the lands which were frequently ravaged by its waters, he assembled the proprietors of those lands, and explained to them the great general advantages that would result from confining the river within a constant



stant channel; adding, that this could not be done, unless they would enter into an agreement, and give him full power to execute in the most convenient manner his plan, which he shewed them; fixing, at the same time, how much an acre should be paid by those who gained land to those who lost it; and, in order to favour the project, all the expenses attending it were to be defrayed by the king. The known talents and character of M. Matthey induced all who had an interest in the business, to place entire confidence in him; and the plan was executed, very greatly to the advantage of a vast extent of country, which the *Po* had devastated so much the more, on account of all that was done by those who had estates on one side, to secure their own lands, by throwing back the river to the opposite side. I have seen, in my travels, many places where it would be advantageous to adopt a plan similar to this; which I have been led here to explain, by what I observed along the course of those little streams, the *Tale* and the *Otter*.

*August 22d 23d and 24th.* When I arrived on the evening of the 21st at the house of my friend Mrs. Burges, I had been engaged, ever since the 26th of June, in a course of almost continual fatigues: I had not yet, however, completed the whole of my plan in this journey; and having great need of a little rest before I resumed it, I could not have chosen a place more suitable for this purpose than *Ashfield*, where Mrs. Burges herself, and her neighbours

hours whom I mentioned before, were all kindly desirous to promote my views. My first object was to observe the western part of the coast of *Somersetshire*; whence I meant afterwards to proceed eastward to the bay of *Bridgewater*, which was already known to me. Having communicated this plan to my friend Mr. Short of *Teignmouth*, he had been so good as to procure for me an invitation from Sir JOHN TREVELYAN to his seat at *Nettlecombe*, near that part of the *Somersetshire* coast which I had first in view; and I wished to go thither strait over the hills, crossing the small rivers that flow in their vales: but I should have found it difficult to execute this project, without such assistance as I here obtained. Mrs. Burges sent with me a man on horseback as my guide; a horse for myself was lent to me at *Wolford Lodge*; and Miss CHARLOTTE SIMCOE, of whose talents in drawing maps a specimen has appeared in that of some part of the coasts of the *Baltic* and *North sea*, prefixed to the first volume of these Travels, was so kind as to copy for me that part of Colonel Mudge's large topographical map, which contained the tract of country that I was now to cross.

*August 25th.* I set out from *Ashfield* at a little after one o'clock, and ascended to the top of the *Blackdown hills* by a road passing above *Wolford Lodge*. Proceeding thence along the western border of this ridge, I perceived it to be intersected by *combes*, separated by promontories, some of which

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terminate

terminate abruptly on the side towards the valley of the *Tale*, like those already described on the *Honiton* side. Hence I saw a great extent of these eminences to the eastward, where I could not distinguish their inflexions. The whole surface is covered with those large masses of *flint*, which have before been a great object of examination in this work, and which are spread on a very deep bed of yellowish sand, as appears in many excavations, and in the sides of the roads. I then crossed the upper part of a large *combe* descending from the eastward, wherein flows a brook, in its way to join the small river *Culm*, which, as I have already said, falls into the *Er* above *Cowley bridge*. I descended considerably before I came down to the level of that river, leaving on each side a large promontory terminating abruptly, like those mentioned above. In this valley lies *Hemyoke*, the clergyman of which village, Mr. LAND, was the following year so good at to give me some information that I shall introduce hereafter, respecting the *limestone* of the neighbouring country. I saw that the eastern extremity of this valley was divided into three branches: the *Culm* proceeds from one of these, and flows along the valley through meadows, according to the account given me at *Cowley bridge*. (§ 1340); the two other branches are only *combes*, containing brooks which fall into the river.

1348. After having crossed this valley, I ascended a new ridge of hills, of the same nature with the preceding,

eding, and covered also with a great abundance  
*flints*, but more cultivated. My guide led me a  
 way out of the road, in order to shew me, in  
 of the fields, what is here called a *Barrow*; by  
 which I understood a *tumulus*, or one of the small  
 mounds raised by the ancient inhabitants of the  
 country; but, on coming up to it, I found it of an  
 in much more modern; and its name, *Simon's*  
*barrow*, brings it near our own times. It is obvi-  
 ously the work of the first cultivators of the hill,  
 who were obliged to clear away the flints, before  
 they could plough the land; as is the case in all  
 countries where the surface is covered with a great  
 quantity of stones, of which I have given many  
 examples. This heap is nearly conical, and its base  
 covers at least an acre of ground. A long time must  
 have elapsed since the neighbouring land was  
 brought into cultivation; for the stones at the top  
 of the heap are covered with lichens, and the vege-  
 tation on the earth, which has accumulated between them,  
 shows abundance of plants: the fields, however,  
 are not yet entirely cleared of all the large stones,  
 which are still taken up whenever they are ploughed;  
 and the new accumulations, around the base of the  
*barrow*, are easily distinguished from the rest; and  
 there were in the fields several small heaps which  
 have not yet been removed. This kind of *chronon-*  
*ter* is found in all the countries where cultivation,  
 gradually gaining on waste lands, has not yet ex-  
 tended itself over the whole.

1349. When I came to the northern brow of these hills, I saw another ridge rising beyond a very wide valley, wherein the small town of *Wellington* is situated. On descending into this valley, I found there a very different soil, consisting of that red marl with blue stripes, which, as I have said, appears also at the foot of the hills to the eastward of those of *Blackdown*; and as I came near *Wellington*, I saw the *red strata* at the bottom of the valley. Throughout the whole of the extensive space lying between the hills which I had just descended, and the town, I did not cross any stream; however, I saw here and there some meadows intersected with ditches, whence it is evident that some rivulet circulates in them, and that they are subject to inundation from the rain waters. At half past six I arrived at *Wellington*, where I passed the night.

*August 26th.* The rain prevented me from setting out before half past nine in the morning. I had still a mile to cross of the breadth of the valley, on the bottom of which I saw a multitude of little mounds, consisting of masses of *red strata* left at a higher level than the rest, and evidently signs of the catastrophe whereby it was originally formed. For some way, the soil was still covered with flinty gravel; but as I advanced, this was succeeded by stones of other kinds. I found the small river *Tone* flowing through meadows at the foot of the hills on the opposite side of this large valley; and I learnt from a countryman whom I happened to meet, that these meadows

meadows are of much greater breadth both above and below the bridge by which I was to cross the stream, than at the point where it is built; that in winter they are inundated; but that their soil is gaining in height by the sediments of the waters. I must here pause for a moment to consider the space over which I had now passed, and in which are two rivers, flowing near each other, and having almost parallel courses: one of these, the *Calm*, proceeds, as I have said, to join the *Er*, and accompanies it to the sea on the southern coast; and the *Tone* falls into the *Parrot*, which discharges itself into the sea on the northern coast; while both flow in vallies bearing no proportion to the volume of the streams. This circumstance, with the descriptions that I shall continue to give of the hills, shews that these vallies bear all the characters of *original* channels, which the streams formed by the rain-waters found in their course when they began to flow.

1850. I crossed several ridges of hills in my way to *Milverton*, a village situated in a vale watered only by a brook. Hence I ascended a higher ridge, from the top of which I had a view of as great a chaos as can possibly be imagined; and I have been told that the same kind of country prevails throughout all the north of *Devonshire*. The hills, lower than those that I had already passed, being dispersed without any order or common direction, they form, when seen from the heights, a very interesting and beautiful scene, by the great diversity

I am speaking has been produced by the subsidence of all the surrounding masses, is, that it is itself crossed from top to bottom by a fissure three or four feet in breadth, filled, like a vein, with other materials; and the *strata* have not preserved the same level on its opposite sides. The catastrophe which formed these hills must have been very violent, since masses of the same *breccia* are, as I have said, scattered on the surface of the hills, over which I had passed in my way to *Wiveliscombe*. These *strata* are very hard; great masses of them are detached with gunpowder, and afterwards broken with large hammers, for the purpose of taking out the parts proper to be burnt into lime; and the terrace which I have mentioned is formed of the other parts thrown out upon the slope.

1353. This *breccia*, like that in the cliffs near *Teignmouth*, contains rounded masses of *grey wacke*, amongst the others of a very hard greyish *lime stone*: but the latter are much the most abundant; and here, many successive *strata* are found of the same kind; whereas at *Teignmouth*, there are only some *strata* of *breccia* among others which are homogeneous. However, though the *strata* of this eminence are almost all of *breccia*, and must be cleared away from top to bottom, they are not all used for lime; those being chosen for this purpose, which contain the fewest fragments of *grey wacke*, and in which the fragments of *lime-stone* lie the most closely together; because it is difficult to detach the masses from the red substance wherein they are imbedded,

added, it being so greatly indurated, that it resists the stroke of the hammer almost as much as the stones themselves; and though it is susceptible of calcination, it does not produce a good lime: as for masses of *grey wacke*, they are picked out from the rest as carefully as possible; and those which happen to remain, are afterwards found among the strata, where they have undergone no other change than that of assuming a reddish tinge on the outside.

The most proper for this purpose are the lower strata; those above them contain fewer calcareous particles, and are used for building stone. Under the strata of *breccia*, there are some of the same substance which are homogeneous, except that they are veined with blue: these are also very hard; being easily split into flags in the direction of the strata, they are used for flat pavements, and for coping of stone fences: these were worked to the height of some feet above the level of the terrace; the workmen told me, that below them were strata of *breccia*, similar to those of the upper part.

Another eminence of the same nature, which I had seen from a distance, belongs to another hill, separated from this by a combe; it is worked on the top of its fronts, and rises also as an obelisk, from the top of the sides of the combe; its strata, nearly horizontal, being laterally broken off in the same manner as those of the former. I inquired whether there were any similar strata in the neighbourhood; the workmen told me that there were none farther toward, but that they were found here and there

to



to the east, within an extent of eight or ten miles, and always on the top of the hills.

1354. On quitting this spot, which is in itself very remarkable, and will appear still more so, when I shall have proceeded farther in my description of this part of the country, I crossed the ridge of hills consisting of *red strata*, to which belong these mounts of *breccia*, and which forms one of the sides of a large *combe* having its opposite side of *schistus*; in ascending the latter, I here and there saw the *strata* inclined in the direction of the slope; but I perceived nothing more of them, either at the top of the hill, or on its opposite slope towards another valley, as they were covered with a very thick loose soil: they again appeared, however, on the ridge of hills bordering the other side of this valley, their *section*, on its summit, forming a kind of pavement in several parts of the high road to *Watchet*, which I here entered, and followed for some way: their inclination is opposite to that of the *strata* in the hills on the side of the valley which I had first passed. I had hence a view to the eastward of the whole chain of the *Quantock hills*, in a direction from S. E. to N. W. where it terminates towards the sea in several very remarkable terraces, which I shall describe in the sequel; and to the west of this chain, I saw several distinct hills, marked in the maps with their names: the first and highest of these forms a cape on the coast, and is called *North hill*; following this to the south, but not  
on

same line, are *Dunster hill*, *Dunkery beacon*, the *Brendon hills*; with many insulated mounts and these higher eminences. From this road, I branched into another to the westward; which led me to *Nettlecombe*, where I arrived at half past five.

5. Sir John Trevelyan, having been informed of my views by Mr. Short, received me in a very obliging manner, and offered to assist me in the ensuing day. After dinner, I walked over his park, which are included several hills, on the slopes of the *Brendons* towards the sea. I have seen very agreeable examples of that *repose of nature* so beautifully represented by M. DEKANDOLLE in his description of the *Pyrenees*; where he speaks of the time "when active nature, so ready to take possession of every part of the surface which enjoys rest; but so often expelled from the sides of the mountains by the last convulsions of those expiring giants, shall peacefully establish itself on their lifeless limbs." At the foot of the most extraordinary catastrophes is here covered with a mantle of the finest verdure, intermingled with woods; the internal state of the ground is never known by the quarries which Sir John has dug in several places: from one at the top of the *Brendon hills* are taken the best *slates* for roofs that are used in all this neighbourhood; and they are transported to a great distance; at the foot, there are black quarries in *schisti*, intermixed with *grey-wacke*,

*wacke*, here used to build stone fences and cottages: these *strata* are broken, and inclined towards different points in different hills, which evidently appear to be only masses of strata fallen in disorder towards the side, where, by the last great *subsidence* of the surface of the globe, the present bed of the sea has been produced. By the springs issuing from the *combes* within the park, and those of the eminences above it, a rivulet is formed, which is received below into a fish-pond, whence it falls on a mill; it then enters a small vale; and being afterwards joined by some other streams, they proceed together to discharge themselves into the sea, near *Donniford*.

*August 27th.* Sir John Trevelyan was so good as to take me with him down to the coast, chiefly for the purpose of shewing me a very remarkable phenomenon which he had described to me the day before. With this view, we first went to *Watchet*, a small port formed in a cove by a semicircular pier, (of the kind called *cobs* in this part of the country;) this pier begins from a projection of the coast on the west, and terminates near another projection on the east, leaving at the latter point the entrance for small vessels, which lie here as in a basin; they come in at high water, and are sheltered from the waves.

1856. The phenomenon of which Sir John Trevelyan had spoken to me, may be viewed from the cob while the tide is out, as was the case at the time of our arrival; when, the bottom of the sea being uncovered  
from

from *Watchet* to *Donniford*, I saw it to be formed by the section of inclined *strata* of a kind of *limestone*, which is unknown on the eminences of the country, and not found any where else in this neighbourhood; but it is met with on the opposite coast of *Glamorganshire* in *Wales*. Advancing on the cob, I observed below, on the part abandoned by the water, a number of men, who were filling the panniers of their asses with fragments of these strata, which are easily detached, on account of the multitude of the fractures, and are burnt into lime at *Watchet*. This stone is of a nature so perfectly distinct, that it cannot be confounded with any other: it has the same property as gypsum; for its *lime* becomes hard as soon as it is wetted. In building walls which are to be under water, or constructing channels wherein water is to flow, nothing more is necessary than to place the stones in the proper order, and then, moistening this lime, to pour it quickly between them; for it acquires its usual degree of induration, though covered with water immediately afterwards. It is this *lime* that has at last supplied the means of building solidly a light-house on the *Eddystone*; which, being a rock in the midst of the sea at some distance from *Plymouth*, is constantly beaten by the waves when there is any wind, and no former light-house ever stood on it for any great length of time. This *lime*, as Sir John informed me, cannot be used in agriculture, because of the above property; for if rain comes on before it is incorporated with the earth, and comminuted by the plough, it becomes like so much gravel

gravel scattered on the soil; all its small masses being them harder, and not less insoluble, than the stone itself before it has been burnt.

1357. This is one of the phenomena which, in my Letters, I had opposed to Dr. Hutton's assertion that no other cause than a *heat of fusion* could have consolidated our mineral strata: I allowed that this was indeed true, according to his system, in which these strata are supposed to have originated in the *detritus* of preceding continents, scattered over the bottom of the sea; but observed that the case was very different with respect to substances chemically precipitated within its bosom, and possessing the faculty of *indurating* even in a liquid; and among other substances to which that faculty belongs, I particularly mentioned this kind of *lime*.

1358. The inclined *calcareous strata*, the section whereof composes the bottom of this part of the *Bristol channel*, afford also a striking symptom of the catastrophe which formed the present bed of the sea, by the *subsidence* of the strata throughout a great extent of the globe; as I have shewn by many other examples around this island. The coast here likewise bears the character so generally indicative of this revolution. The two capes that form the cove of *Watchet*, though they are at the level of the sea, consist of the *red strata*, by which, on the hills of *Nettlecombe*, as well as on others already described, the *schisti* are covered; and which having been  
broken

broken in their fall towards the point of the great subsidence, have assumed different inclinations, being seen, in the western cape, to rise towards the sea and incline backwards, while, in the eastern, they incline towards the sea: and this is also a symptom which I have frequently pointed out in other cliffs of different kinds of strata. As the fragments of the strata on the bottom of the sea are here so constantly gathered up when the tide is out, the waves have not been able to raise a beach at the foot of these capes, and therefore still beat against them at high water; but farther eastward, where they find gravel, and impel it towards the coast, I saw that at the foot of a similar cape, which was now reduced into a talus and covered with grass, a beach had been raised.

1359. On the west of *Watchet*, and consequently nearer to the open sea, the bottom of the *Bristol Channel* is covered with a great abundance of sand; we followed the shore on that side, where the land slopes gently down to the sea; and I saw there, added to the coast by the sand which the waves and the tides have brought up against it, an extensive tract of new grounds, in many parts intersected by slips of the original land rising very little above their level; but these slips are very easily discerned by their *red soil*, and by a small ridge of gravel which the waves have raised in front of them. In our way, we crossed two small streams; one of these might easily have been stepped over; the other we  
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passed below *Dunster castle* on a small bridge, above which a bar of gravel has extended itself, keeping the water at a higher level in the meadows. Beyond the bridge, the *new grounds*, distinguishable by their perfect *horizontality*, are of very great extent, and are secured against the sea by imbankments. We proceeded to a point whence we saw, at the foot of a cape formed by the lofty eminence called *North hill*, the small town of *Minehead*, where a port has been formed in the same manner as at *Watchet*. *Minehead* being still at some distance, we had not time to go on to it; but Sir John Trevelyan, having taken notice that I observed particularly what streams we crossed, told me that the last arriving on this side in the bay (fifteen or sixteen miles in breadth, from this cape to another formed by the *Quantock hills*,) was smaller than that which we had just crossed by the little bridge: and that the most considerable of these streams, likewise however but small, rises in the hills above *Nettlecombe*, and falls into the sea near the latter of the capes.

1360. From the above point, we had a prospect of the hills encompassing the great extent of meadows on the *new lands* of which I have been speaking, and through a part of which flows the small stream arriving at the sea near *Minehead*. Two *hills*, there rising in a conical form, have visibly been formerly *islands*, in the bay; for they are surrounded with these *new lands*, by which the water of the sea has been displaced: the eminence nearest to *North hill* is

is called *Conigar*; it is covered with wood, and has a tower on its summit; on the other stands *Dunster Castle*, an ancient seat of the LUTTRELL family, to whom this manor belongs. Farther on, two *combes* terminate at the coast; one proceeding immediately from the high hills, and the other descending obliquely behind the two insulated hills: from the latter issues the stream which we had crossed on the small bridge, and which has preserved its course through the meadows. The little river *Tone* rises in the *combes* of the opposite side of these hills; then, passing to the eastward of the *Quantocks*, it turns back, as I have already had occasion to say, towards the same sea, and falls into the *Parrot*, which discharges itself into *Bridgewater bay*. On the west of these hills lies *Exmoor*, the waters of which when collected, form the *Ex*, and proceed to the sea on the southern coast.

1361. After our return to *Nettlecombe house*, the subject of the *lime-stone* which forms the bottom of the sea before *Watchet* being resumed, Sir John mentioned to me another *lime-stone* of a quite different nature, discovered in a vale four miles distant to the westward, and he offered to send his steward with me the next morning in his carriage to shew me the place, an offer which I very gladly accepted.

*August 28th.* We set out in the morning on this excursion; and in passing through the park, I re-



marked a circumstance, which I have often observed in other places, and which proves what I have said respecting the effect of the *grass* that covers the loose soils of the hills, in putting a stop to the action of the rain-water on those soils. There had been some rain the preceding days, and even this morning before we set out: in part of the park, the grass is on the *red soil*, which colours the waters more than any other; yet the little rills still flowing here were perfectly limpid: but when, on quitting the park, we crossed a rivulet proceeding from arable lands, I saw that it was deeply tinged.

1362. I have said that the *red strata*, which form the *cliffs* near *Watchet*, cover the *schisti* in the hills above, and that they appear in the park of *Nettlecombe*. A little after we had quitted the park, in passing over a hill the slopes of which were cultivated, I saw a great excavation, whence was taken stone for building; this was *grey wacke*, intermixed with *schistus*; and the *strata* of both, very much inclined, obliquely cross the direction of this part of the hill. As we afterwards descended on the opposite side, I there observed the slope to be formed by the planes of the *strata* of a *schistus* much foliated; which shews the great variety of the fractures and angular motions of the *strata* in their catastrophes; but a more surprising effect will presently be seen; since, in consequence of these catastrophes, certain *lime-stone strata*, which must necessarily have covered

covered the *schisti* to a great extent, are now found only in the spot which was the object of our present excursion.

1963. After having wound for some way between the hills, my guide made me quit the chaise, and led me into a field belonging to the parish of *Stogumber*, where the *lime-stone* that was our present object, had been dug in many places. This stone, which is very hard and has a fine grain, was first discovered in the highest part of the field, where some rocks of it appear level with the surface: these rocks are the summits of pyramids buried under the *red-strata*; and by following their track on the surface, a point was reached which the workmen call the *nose of the rock*, it being the *section* of the *strata* towards a small vale, covered by a slope of loose soil; and as the latter was easily cleared away, the materials removed being thrown down the descent, the *strata* were here accessible with less trouble than in the part appearing at the surface of the high ground. They have therefore been worked ever since on this line: but in many places the *section* has been found interrupted, as it is only that of the masses of *lime-stone* which were overturned, and which, having been first covered by the *red strata*, were afterwards again broken by the *subsidence* that produced the *vale*. This is the same phenomenon which I have described in the *strata* of soft white *lime-stone* at *Offwell* and *Widworthy* in *Devonshire*, and in those of *granite* in the hills of

*St. Columb and Tregonning in Cornwall.* The *strata* of this hard *lime-stone* are inclined, descending towards the *vale*, where they are buried under the *red strata*; and as their depth increases on the opposite side of the *vale*, no farther exterior indications of them are found in that direction. Thus, within a small space, are seen *strata* of both the kinds which are contained in the *breccias* lately described at *Wiveliscombe*, namely, *grey wacke*, and this very hard *lime-stone* with a fine grain; and I shall proceed to mention other circumstances, whence will still more manifestly appear the nature of the revolutions which happened on this part of the bottom of the ancient sea.

1364. My guide next led me towards the valley beyond which rose the chain of the *Quantock hills*, where the country presented a quite different aspect; the hills forming the western side of this wide valley have not the rounded forms of those in the neighbourhood of *Nettlecombe*, for their whole appearance shews them to have bordered the great subsidence which produced the valley itself, they are all cut down abruptly towards it, having on the opposite side gentle slopes, but in different directions; and their very nature leads us to the confines of great mysteries in Geology. We ascended the nearest of these *hills*, and I found it to be of the same nature as those near *Wiveliscombe*; its abrupt side being the section of *strata* of *breccia*, here also worked to make *lime*; the substance wherein the rounded  
masses

masses are imbedded is less red and more calcareous than in the former ; there are here fewer fragments of *spacke*, and the masses of *lime-stone*, which are larger, equally hard, and with the same fine grain, have a greater resemblance in colour to those ruins of *strata* of the same nature that we had just seen under the *red soil*. In the *strata* of this hill likewise there are vertical fissures, which the workmen call *joints*, and are very glad to find, because they much facilitate the working : these *strata* also, like those of *Wiveliscombe*, have not preserved the same relative level on the opposite sides of the fissures, which here are filled with a sparry gangue, wherein I saw some very singular crystals. The workmen pointed out to me, at a little distance, another hill of the same form, where they told me the working was more expensive, because there were no joints ; its abrupt side and the opposite slope are in different directions from those of the hill which we had ascended. The rounded stones taken out of these *breccias* are here called *pobbles* ; probably a corruption of *pebbles* ; and the workmen told me that these were found in all the hills of the same form then within our view on this side of the valley, but not on the other side, formed by the *Quantock hills*.

1365. This was the association of circumstances which I had in view in §§ 1008 and 1020, when describing the cliffs at *Budleigh Salterton* and *Teignmouth*, in a part of *Devonshire* where the *strata* of *grey wacke* and hard *lime-stone*, to which belong the masses

flowing through large meadows in the park belonging to Lord EGREMONT; I followed this branch up to *Williton*, where it issues from a defile, which has certainly not been produced by its action; for when I ascended the hill on one of the sides, I had a view of the course of this stream, through another tract of meadows, before it enters this narrow passage. After this, I crossed some other small hills, in the last of which, very near the *Quantocks*, I saw quarries of blue lyas, a kind of lime-stone very different from those that I have described, either near *Nettlecombe*, or in the sea at *Watchet*: I particularly mention the blue lyas here, because I met with it again immediately on the opposite side of the great chain, which is of an entirely different nature.

1368. As I approached *West Quantoxhead*, a village situated at the extremity of the chain, which rises from this point, I crossed the bottom of a *combe* ascending to the summit of the hills in a direction parallel with theirs, as formed by a ridge detaching itself from the rest, and advancing separately towards the sea: this *combe* cannot have owed its origin to the brook which issues from it, the latter being only sufficient to water the meadows that cover the whole of its lower part and rise some way up its sides. This extremity of the chain descends towards the sea in several terraces, which exhibit different kinds of *strata*. The terraces themselves are intersected by *combes*; and that the road may be as little interrupted by these as possible, it is carried  
along

along at a considerable height on the slope. In travelling on this road, I could scarcely perceive the rivulets descending from the heights and flowing down the *combes*, at the bottom of which I saw meadows, whenever, in crossing them above, I came to points whence I had a view of their whole extent. All the upper part of the slope of the hill is covered with heath; but *wacke* is seen in several quarries opened for gravelling the road and for building, and rocks of it appear also here and there amidst the heath; its *strata* incline various ways, according to the direction of the partial subsidences which produced the *combes* in this elevated part. The lower terraces consist of the *red strata*, which likewise form the *cliffs* towards the sea, as I saw on the sides of some of them considerably below me. These *cliffs*, when viewed from the sea, must have a scalloped outline; being sections of the *hills* and of the *combes* which separate them. Above *Holford*, a *combe* descends from the upper part of these eminences down to the sea; and a brook formed by springs in higher ground, after flowing some time on gravel along the terrace where the road passes, continues its way into the lower part of this *combe*.

1369. After having passed the principal branches of this extremity of the *Quantock hills*, I crossed the lower part of a *valley*, which, like the *combe* on the opposite side, is in a direction parallel with their chain. In this *valley* appears, still more evidently than in the *combe*, that it has not been formed by the brook

now

now flowing in it; for one of its sides, namely, the foot of the *Quantock hills*, consists of *wacke*, while the other is of the *blue lyas*, which has been seen also on the opposite side of the chain. I then followed, at a certain height, the slope of the *Quantocks* to the N. E.: and the whole way I had a very fine view of the ancient bay of *Bridgewater*, with its surrounding hills, as far as the *Mendips*: a prospect in which the utmost degree of rural beauty is combined with very distinct monuments of the history of our continents. I knew, from my journey the preceding year, that the vast extent of meadows, here lying before me, filled up a space that had been originally occupied by the sea; all the eminences, therefore, which I saw rising above the level of these meadows, had been *islands* in a bay, where the projecting branches of the hills had then formed promontories. In my way, I passed by a spot in the hill where I saw external indications of a mine; and I learnt that a vein of copper had for some time been followed there, but had not proved rich enough to defray the expense of a steam-engine, when it became necessary to pump out the water.

1370. I then descended towards the small town of *Nether Stowey*; and in looking back on the chain of the *Quantocks*, I had a very beautiful view of those hills, which the heath, now in blossom, appeared to cover with a purple carpet, the paths and the tracts of the rivulets forming on it a fanciful embroidery. When I came to the low hills, I found myself in  
richly

richly cultivated land, interspersed with the fine elms which so greatly embellish this county; and the little town of *Stowey* appeared to consist almost entirely of pretty country houses. These hills are covered with the *red soil*; and wherever it was cut through on the sides of the road, I could see that it had buried under it the ruins of *sand-stone* strata, some red, and others grey, which were inclined towards different points, according to the sides where their partial *subsidences* had taken place. The superficial soil contains a great deal of gravel of *grey wacke*, used, for some way, to mend the road; but afterwards I found employed for this purpose fragments of a *lime-stone* which was quite different from the *blue lias*, being very hard, and intersected with numerous sparry veins; when I inquired whence this stone was brought, a mount composed of it was shown to me at a little distance, rising above the *red soil*, near a place called *Parkhouse*. Thus it is impossible to pass over a certain extent of this country, without finding, in the variety of *strata* appearing at the surface, very evident signs of the astonishing catastrophes which all the *mineral strata* underwent before the birth of the continents. At half past six, I reached *Bridgewater*, where Mr. Jenkins was so good as to lodge me at his house.

*August 30th.* I allowed myself this day for rest, being at a place where I could spend it both with pleasure and advantage. Here I again met with Mr. R. Anstice and M. Pains, whom I mentioned  
in



...had been originally occupied by the ...  
already given those proofs, and no doubt  
them can be entertained. My object  
excursion was to observe some *chronolo-*  
*ments* which had been mentioned to  
Anstice, and which furnish *dates* in the  
these operations of the *sea* and of the *lan-*

*August 31st.* At eleven in the mo  
Anstice and I set out in his chaise from *E*  
and first crossed the meadows on the ri  
the *Parrot* towards *Bawdrupp*; this villa  
ed on the S. W. of *Polden hill*, a low r  
as I have said, advances forward consi  
the ancient bay; having originally formed  
and narrow promontory, united to the l  
a very low isthmus, - now separating the  
of the courses of the *Parrot* and the *B*  
as the meadows have increased in extent  
longed their channels through them. I  
*Polden hill* at a place called *Knowle*, in  
bourhood of which have been found in

Antiquarian Society in *London*. The stone coming from this eminence is called in the country *Jewell*; it is *calcareous*, and is, like the *lyas*, in thin strata; but its surface is very rugged, while that of *lyas* is smooth.

1871. Beyond this ridge of small hills, we came to a part of the meadows, where Mr. Anstice had been overseer of the works carried on to straiten and deepen the channel of the *Brue*; and he shewed me a point in this channel, where, after having dug, to a depth of seven feet in the *sediments* of the river, and being come to the surface of the *peat* which lay beneath them, there had been found on that *peat* a heap of fragments of pottery, with pieces of the small bricks used to support and separate the vessels in the kilns where they were baked. This is a very remarkable monument, which confirms the truth of what I have elsewhere said of the nature of the *new lands* formed along low coasts, in parts where the water, from the nature of the soil, are covered with *peat*. Here, the *peat* has flowed down over the lands composed of *sediments*, which, by degrees, have subsided, sliding towards the sea; and their level being thus lowered, the whole mass has been covered with new *sediments*. This *peat*, at present buried, was certainly uncovered at the time when the Romans inhabited this country, as is proved by other similar monuments, which were shewn to me by Mr. Anstice in the vicinity of this place. In ascending

ascending the course of the river, the thickness of the *sediments* covering the *peat* is seen, in the section of the channel, to diminish, till at last they disappear, and the peat alone forms the surface to a vast extent; hence these lands are called *moors*; and they are divided into districts, distinguished by names; as *King's Sedgemoor*, *West Sedgemoor*, and *East Sedgemoor*; (*sedge* being the English name of a *carex*, which grows in great abundance on these *peat-grounds*;) the moor whereon we then were is called *Burtlemoor*. Mr. Anstice made me remark on it a line of small mounts, covered only with turf; and he told me that these were heaps of fragments of pottery, like that which had been found, at a lower level, under the *sediments* of the water, in digging the new channel for the river. Thus, since the period when the Romans inhabited this country, a part of the surface on which they were settled has sunk seven feet below its original level.

1372. That these are the fragments of *Roman potteries*, is placed beyond a doubt by other monuments, which are mentioned by CAMDEN in his *Britannia*, as having been found in digging, not far from hence, near *Edington Burtle*; these are *moulds* of Roman coins, made in *terra cotta* by false coiners. Not long since, the Rev. J. POOLE, a clergyman in the neighbourhood, was led by some external indications to have the ground dug up near  
that

that place; and within a space of four feet square, he found buried, about a foot below the surface, a great number of these *moulds*, respecting which he presented a very interesting paper to the Antiquarian Society, wherein he mentions some places in *Shropshire* and *Yorkshire*, where such *moulds* have also been found; moreover, he quotes a paper in the third Vol. of the *Académie des Inscriptions* at *Paris*, in which it is proved that similar *moulds* recently found near *Lyons* were the work of false coiners, who thus produced very good imitations of the lawful coins, though the latter were *struck*. Mr. Poole then remarks, that, in the above places, the only coins imitated were those of SEVERUS, and CARACALLA; while among those which he had found in *Somersetshire*, there were some of GETA, MACRINUS, ELAGABALUS, ALEXANDER SEVERUS, MAXIMIN, and MAXIMUS, together with many bearing female heads. Lastly, Mr. Anstice himself, in digging the channel of the *Brue*, found a kind of nest of these *moulds*, which had been hidden in the peat; he had shewn me several of them at *Bridgewater*; and in one the coin moulded in it still remained. It is therefore certain, that, at the time when the Romans were settled in this country, the surface of this part of *peat* soil was still above the level of the inundations, which yet, in consequence of its gradual subsidence, had covered it with sediments to the depth of seven feet, before the new channel was formed for the river; and besides, it will soon be seen that the *sea-sand* had been brought up into this *bay* by the waves and tides,

me by Mr. Anstice, who made me observe the effect of it in some soils near the sea. The first dikes, of which I have just spoken, bordered only a third part of the coast now enclosed; the tides continued to spread themselves over the rest, and at the same time that they raised its soil, the sand-banks were impelled by the waves against the coast. It is in this part that the *peat*, having slidden down towards the sea, is at the greatest depth below the superficial soil, principally composed of *sea-sand* mixed with the sediments of the land-waters, and consequently less liable to subside than that which, being at greater distance from the sea, wholly consists of those sediments. Hence it has resulted, that, since all these meadows have been enclosed with dikes, the rain-waters, carried off by ditches into the new channel of the *Brue*, which is terminated by a sluice, flow at first, in a direction opposite to the sea, towards the part where the level is lowest, and where they unite in that channel with the other waters from the meadows. In our return from these various observations, we passed the foot of a promontory of the original soil, which, at its highest part, where stands the village of *High Ham*, presents towards the meadows the section of its *strata*; on the opposite side, it descends towards the village of *Low Ham*. Hence we proceeded, through the meadows which border the *Parrot*, to *Bridgewater*, where we arrived about three o'clock.

. 1376. Thus, with the assistance here of a man so  
well

well informed as Mr. Anstice, I had accomplished the plan of observations which I had undertaken on the western coast of *England*, from the mouth of the *Severn* in the *Bristol channel*, to the *Land's end*; and along its whole extent I had found nothing but the most complete confirmation of all that I have described along the southern coast, and also the eastern as far northwards as *Yarmouth*; proving, by monuments no less incontestable in themselves, than common to all the coasts of the continent which I have had occasion to observe, that the *sea* has not occupied its *present bed* during a very *great number of ages*. If the authors of those fabulous *histories of the earth* in which an unfathomable *antiquity* is assigned to our *continents*, instead of following the guidance of their own imaginations, had studied facts as carefully as they ought to have done with respect to an object of so much importance to the whole human race, they would neither have fallen into this error themselves, nor drawn into it those who, believing them to be well informed, have placed an entire confidence in their assertions.

*September 1st.* Having passed this morning with Mr. Jenkins, to whom I had been originally indebted for all the assistance which I received in this county, I set out for *Cross* in a post-chaise, at half past three. My road first passed over the foot of the western extremity of *Polden hill*, whence I again descended into the meadows, in the part which separates this extremity from an eminence

nearer the sea, whereon stands the village of *Pawlet*. Originally this eminence certainly formed an *island* in the *bay*; its *strata* are of the same nature with those of *Polden hill*, from which no cause can have divided it since the continent has existed. From thence I entered on the meadows of the *Brue*; and having crossed that river on the new bridge, I went to observe its ancient channel, which, as I said in the preceding volume, it had been intended to fill up with the sediments of the tides, by means of a sluice placed in a direction contrary to the others; and I was surprised at seeing how rapid had been the progress of this operation. I then passed over the foot of *Brent hill*, a large insulated mount in these meadows, which had also been an island in the bay, and has now at its foot two villages, *East Brent* and *South Brent*: it is very steep on the southern side, and descends gradually on the northern, where its slope is cultivated. I passed the *Axe* at *Weare*, and arrived at *Cross* early enough to go to *Compton House* to call on Mr. Fry, who, the year before, had been so obliging as to give me directions for my journey across the *Mendip hills*.

*September 2d.* I set out for *Bristol* at seven o'clock in the morning. *Cross*, as I said in my former journey, is situated in a deep intersection of the *Mendip hills*. It is very evident that this valley is an effect of the catastrophes of the *strata*, and not of the action of any *stream*; for its highest part is about the middle of its length, from which it descends  
towards

towards both extremities; and besides, the aspect of the bordering hills shews that a great subsidence has here taken place, their steep sides being studded with projecting rocks, the *strata* of which, in different parts, have different inclinations. In order to render the road more level, it has been cut through *strata* of *breccia* similar to that described in my former journey as prevailing along the foot of these eminences, on the side next the *Bridgewater* meadows; the section of these *strata* appears on one of the sides of the road.

1377. When I came to the highest part of this passage, I had a view, towards the north, of a great extent of meadows occupying the space of another original *bay*: these are the meadows which I mentioned in my former journey as not requiring any imbankments to secure them against the sea, because they are on a soil of a quite different nature from that of the meadows just described. In the hills surrounding this ancient *bay* is no interval which affords a passage to any river, and there are only a few rivulets formed in their combes; it is therefore filled up almost entirely by the *sea-sand*; so that the soil is much poorer, and less worth the expense of imbankments: it is already so much raised, that cattle may graze on it in summer without danger; and when, during tempests at high water, the sea rushes over it, this soil is so far from being diluted and washed away, that it is, on the contrary, covered with fresh sediments, which are retained by the grass.

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These meadows, like the former, encompass, near the sea, several eminences that were originally islands. After having crossed this extensive space, I ascended a ridge of hills composed of *red strata* alternately hard and soft, on the foot of which I saw scattered *blocks* of the *lime-stone* of the *Mendip-hills*; now as this stone is nearly allied to that of the *Hotwells* near *Bristol*, on the north, as well as to that of the *mount* which I have described near the foot of the *Quantock hills*, on the south-west, these *blocks* appear to indicate that *strata* of this class lie under the soil throughout this whole extent of country, and that these fragments of them were thrown out by the interior fluids, when compressed during the *subsidence* which formed the bay.

1378. In the part where these hills are crossed, their summit is horizontal, and commanded on the east by an eminence with a cultivated slope. When I began to descend on the opposite side, I saw large quarries, in which were worked very regular thick *strata* of a bluish *lime-stone*: these *strata* incline the same way as the slope of the hill, but more rapidly, for their *sections* form the summit. This descent commands a view of a beautiful low valley in a direction towards *Bristol*, through which the *Avon*, if it had not met with the defile of the *Hotwells*, would have taken its course towards the sea, arriving at the coast to the south of the present place of its discharge; and it would then have formed a lake in the part where *Bristol* is situated. From *Bristol*  
I went

I went on to *Bath*, by a road which I have already described.

*Scpember 3d 4th and 5th.* Having spent the morning of the 3d with my friends at *Bath*, I proceeded in the evening to *Pewsey*, in *Wiltshire*, where my daughter was on a visit to her friend Lady CLARKE; with whose husband, the Rev. JOSEPH TOWNSEND, the clergyman of that place, I was myself connected by our common pursuits in Geology. He has in this respect particularly a full knowledge of the part of the country where he resides; and I shall briefly relate the information that I have obtained from him concerning the phenomena which he has here observed.

1379. *Pewsey* is situated in a valley between high hills of *chalk*, which on the north extend towards *Marlborough*, and on the south, by *Salisbury*, to the coast of *Dorsetshire*. In this part of the valley, the *strata* of *chalk* are broken off down to their base: and instead of resting on *strata* of *lime-stone*, as I have shewn to be the case in *Dorsetshire*, they here lie on a greenish *sand*, wherein Mr. Townsend has found many pear-shaped *fungites*; which I mention on account of a circumstance that will follow. The lowest of these *strata* of *chalk* are not proper for making *lime*, because they contain some of this *sand*, together with some *argillaceous* particles; they are distinguished in the country by the name of *malmy chalk*; this also I mention because of its connexion  
with

with another object. On these *strata* are accumulated those of *creta scriptoria*, that chalk which forms white marks, and contains *flints*. Mr. Townsend, who has very much studied these flints, and has formed an interesting collection of their various accidents, has found in them the confirmation of the cause to which, in my *Lettres sur l'Histoire de la Terre et de l'Homme*, I assigned the formation of *silices*; namely, the transmutation of the *chalk* itself into these bodies, by the *siliceous* particles, which, in circulating through its mass, have been retained in certain points by some obstacle, and often by marine bodies. Of this Mr. Townsend has found evident traces in a number of the *flints* in his own neighbourhood, of many of which the nucleus is one of the same *fungites* that are contained in the *sand* beneath all these *strata* of *chalk*.

1380. There is here another remarkable circumstance with respect to the *catastrophes* and change of level which have been undergone by the *strata*; this is, that, on these hills, there is a knoll called *Witcot*, where the *strata* of *malmy chalk* are found on the summit, while elsewhere it clearly appears by their position, and by the sand still contained in them, that they were deposited immediately on the *strata* of the latter. Here also Mr. Townsend gave me a new proof in confirmation of the opinion which I have already stated, that the abundance of *flints*, scattered not only over this southern part of *England*, but over vast tracts of the northern part of the continent,

tinent, where no *strata of chalk* externally appear, proceed from large masses of these *strata* which were dissolved, at a certain period, in the *ancient sea*. This operation is here perceived by the discontinuance of the *chalk* in parts over which it must undoubtedly have extended; for example, when wells are sunk in some high ground between the extremities of *Martin hill* and of *Burbage hill*, the *sand*, wherein the interior waters circulate, is found but a very little way below the surface. This elevated ground, which extends to a considerable length, separates the waters flowing in different directions towards distant points: those of the eastern slopes proceed to join the *Kennet* and the *Thames*; those of the western form that *Avon* of which I have described the mouth at *Christchurch*, on the southern coast. Over all the lower part of this district, beginning in the valley of *Pewsey*, the *flint* gravel is very abundant; while on the western side, where the clay prevails, none of this gravel is found within a breadth of nine miles, as far as *Bishop's Canning*.

1381. Some part of a *canal* carried on through the valley of *Pewsey* has been attended with great expense, because the *sand* above mentioned, being here without any covering of chalk, the water, of which, in summer, a supply can only be obtained by artificial means, filtrated through it; so that it has been necessary to bring *clay* from a great distance, and to lay a thick bed of it over the *sand*; an expedient which has proved successful: Mr. Townsend  
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took me to that spot, where there were large heaps of clay, brought thither for the purpose of repairing the bottom of the *canal*, when found to leak in any part; and I saw there a remarkable phenomenon. This *clay*, in drying, had separated into *balls* formed with concentric *strata*, exactly similar to the *basaltic balls* which I have seen in *Saxony* and *Lusatia*.

1382. The above-mentioned *canal*, in which Mr. Townsend has been much concerned, and of which he was so good as to explain to me all the particulars, shews that there is a succession of low vallies across the whole southern part of *England*. The plan, already very much advanced, is to produce an interior navigation from *Bristol* to *London*, by means of the *Avon*, which arrives at the former place on the western side of the island, and of the *Thames*, which has an easterly course. The first of these rivers is made navigable by a canal, with some sluices nearly to *Pewsey*, where begins another canal, also with sluices; and this, passing over some ground of a moderate height, thence descends into the *Kennet*, by which it is led into the *Thames*. In following the course of these different *vallies*, as I have had occasion to do, it is impossible to doubt that they existed at the birth of the continents. The waters have here so little declivity, that, instead of having been able to excavate, they have levelled the bottoms of the vallies by their sediments, on which large meadows have been formed; and the earthy particles carried to the sea by the *Thames*  
on

on the east, and by the *Avon* on the west, since those rivers began to flow, have formed on the coasts, on both sides of the island, a great extent of horizontal *new grounds*, which are still continuing to increase.

*September 6th.* We set out from *Pewsey*, and arrived at *Windsor* the following day.

## CONCLUDING TRAVELS IN ENGLAND.

1383. From the phenomena which I have principally pointed out in the preceding travels, it may have been judged that my choice of the *Huttonian Theory illustrated by Mr. Playfair*, as a point of comparison with these phenomena, has every where answered the purpose announced at the beginning, that of bringing under discussion all the geological questions requiring the decision of facts. Among these questions, one of the most important is that of which I examined a particular case towards the end of my last journey; namely, what is, in general, the origin of those prodigious quantities of all kinds of *gravel*, which cover tracts of such vast extent on all the continents. Dr. Hutton did not hesitate to consider these *gravels* as consisting of fragments detached from the *strata* subsequently to the birth of the continents, and transported along the surface of the latter by the running waters, which, after having scattered them over the heights, had excavated the vallies wherein the streams formed by these waters at present flow; supplying the deficiency of visible *progress* in this operation, by the immensity of the *time* which he assigned for its continuance.

1384. Mr. Playfair, in his exposition of this system,  
has,

has, however, found himself obliged to treat as exceptions some cases within his own observation, to which it was absolutely impossible that the above cause should be applied, and which he has therefore ascribed to particular causes. I have already had occasion to cite that part of his work, and the examination of it has engaged me in many observations; but there were still remaining two phenomena of this kind, which I had not had yet an opportunity of observing; and as they will form the principal objects of these concluding travels, I must again insert the whole passage relating to them. This subject is introduced by the account of a phenomenon very well described by M. DE SAUSSURE, namely, the *plain of Crau* in *Provence*, the soil of which is evidently a *breccia*, composed of large fragments of *primordial stones*; and after having defined its characters, Mr. Playfair continues thus, p. 372.

“ The theories that have been contrived for explaining the phenomena of the *plain of Crau*, afford an instance of the necessity of generalizing our observations before we can explain a particular appearance: in other words, they prove the truth of Lord BACON’s maxim, *That the explanation of a phenomenon should not be sought for from the study of that phenomenon alone, but from the comparison of it with others.* One of the theories of this *plain* is, that the *breccia*, which is the base of it, is formed from the consolidation of the loose gravel of the plain, by water percolating through  
“ it



“ it, and carrying some *cementing* substance along  
 “ with it, or some *lapidific juice*, as it is called. And  
 “ indeed, whether the *gravel* is formed from the  
 “ *breccia*, or the *breccia* from the *gravel*, is a ques-  
 “ tion which probably could never be resolved by the  
 “ mere examination of the plain itself. But the  
 “ question is very soon decided, when we compare  
 “ what is observed here with other appearances in  
 “ the natural history of the earth’s surface, and con-  
 “ sider how much more frequent the *decomposition*  
 “ of *solids* is, than their *reconsolidation*, in any place  
 “ above the level of the sea.

“ The argument for the *decomposition* of stony sub-  
 “ stances which is afforded by the state of this singular  
 “ *plain*, may be confirmed by the appearances observed  
 “ in many extensive tracts of land all over the world,  
 “ and especially in some parts of *Great Britain*.  
 “ The road to *Exeter* from *Taunton Dean*, between  
 “ the latter and *Honiton*, passes over a large heath  
 “ or down, considerably elevated above the plain of  
 “ *Taunton*. The *rock* which is the base of this  
 “ heath, as far as can be discovered, is *limestone*,  
 “ and over the surface of it large *flints*, in the form  
 “ of *gravel*, are very thickly spread. There is no  
 “ *higher* ground in the neighbourhood from which  
 “ this *gravel* can be supposed to have come, nor any  
 “ *stream* that can have carried it, so that *no expla-*  
 “ *nation* of it *remains*, but that it is formed of the  
 “ *flints* contained in *beds* of *limestone*, which are  
 “ now worn away. The *flints* on the heath are *pre-*  
 “ *cisely*

“ *cisely* of the *kind* found in *limestone*; many of  
 “ them are not much worn, and cannot have travel-  
 “ led far from the rock in which they were originally  
 “ contained. It seems certain, therefore, that they  
 “ are the *debris* of *limestone strata*, now entirely de-  
 “ composed, that once lay above the strata which at  
 “ present form the base of this elevated plain, and  
 “ probably covered them to a considerable height.  
 “ . . . . The same remarks may be made on the high  
 “ plain of *Blackdown*. . . .

“ Again, in the interior of *England*, beginning  
 “ from about *Worcester* and *Birmingham*, and pro-  
 “ ceeding north-east through *Warwickshire*, *Leices-*  
 “ *tershire*, *Nottinghamshire*, as far as the south of  
 “ *Yorkshire*, a particular species of highly indurated  
 “ gravel, formed of *granulated quartz*, is found every  
 “ where in great abundance. This same *gravel* ex-  
 “ tends to the west and north-west, as far as *Ash-*  
 “ *burn* in *Derbyshire*, and perhaps still farther to  
 “ the north. The quantity of it about *Birmingham*  
 “ is very remarkable, as well as in many other places;  
 “ and the phenomenon is the more surprizing, that  
 “ no *rock* of the same sort is seen in its native place.  
 “ . . . This enigma is explained, however, when it is  
 “ observed, that the basis of the whole tract just  
 “ described is a *red sandstone*, often containing in it  
 “ a hard quartzy gravel, perfectly similar to that  
 “ which has just been mentioned. From the *dissol-*  
 “ *ution* of *beds* of this *sandstone*, which formerly  
 “ covered

“ covered the present, there can be no doubt that  
 “ this gravel is derived. But, as the *gravel* is in  
 “ general thinly dispersed through the *sandstone*, and  
 “ abounds only in some of its layers, it should there-  
 “ fore seem, that a vast body of *strata* must have  
 “ been worn away and *decomposed*, before such quan-  
 “ tities of *gravel* as now exist in the soil could have  
 “ been let loose.

“ I have said, that a *rock* capable of affording  
 “ such gravel as this, is not to be found in the tract  
 “ of country just mentioned. This, however, is not  
 “ strictly true ; for in *Worcestershire*, between  
 “ *Bromesgrove* and *Birmingham*, about seven miles  
 “ from the latter, a *rock* is found consisting of indu-  
 “ rated strata, greatly elevated, and without doubt  
 “ primitive, from the detritus of which such *gravel*  
 “ as we are now speaking of might be produced.  
 “ These *strata* seem to rise up from under the se-  
 “ condary, where they are intersected by the road ;  
 “ and, for as much as appears, are not of great  
 “ thickness, so that they cannot have afforded the  
 “ materials of this *gravel directly*, though they may  
 “ have done so *indirectly*, or through the medium of  
 “ the *red sandstone* ; that is to say, a *primary rock*  
 “ of which they are the *remains*, may have afforded  
 “ materials for the *gravel* in the *sandstone* ; and this  
 “ *sandstone* may in its turn have afforded the mate-  
 “ rials of the present soil, and particularly the *gravel*  
 “ contained in it.”

1385. The controversies, which are still subsisting in almost all branches of the natural sciences, could not have been so long continued, if those who support systems, instead of defining their objects by general characters represented according to their own conceptions, had determined them by precise examples, taken from places where all the circumstances might be submitted to examination. It has therefore been chiefly on this account that I have been led to fix my attention on Mr. Playfair's work, where, on many occasions, he refers to examples of this kind; in the above passage, especially; he adduces two cases, which I have thought it particularly essential to examine, because they relate to the great geological object of the *gravels* scattered over the continents.

1386. The example taken from the *flinty gravel* scattered over some of the *Devonshire* hills was, from its nature, an object of particular interest. This is a *gravel* not composed of *fragments*, but of *siliceous bodies*, which have certainly been formed in *calcareous strata*; and the geological importance of the phenomenon consists in the dissemination of such *gravel* over many countries where no *strata* of that nature anywhere appear. Mr. Playfair, supposing that the *Blackdown hills*, on which are scattered the *flints* mentioned in the above passage, had *strata* of *lime-stone* for their base, and that in the latter were contained *flints precisely* of the same species as those on the surface, conceived that all this abundance of

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*gravel*

*gravel* had been disengaged from a mass of these *strata*, destroyed by the actions of the air. In my preceding travels has been seen how much time I employed in examining, not merely the *Blackdown hills*, but those of *Haldon*, which follow them to the westward of *Exeter*, and are confusedly mentioned by Mr. Playfair : both these chains are covered with the same *gravel* ; and in every part of them over which I had passed, I had found nothing, *as far as could be discovered*, but *strata* of *sand* and *sand-stone*. But I had been told, among other circumstances, that some *calcareous strata* were worked for lime at the eastern extremity of the *Blackdown hills*, which is the part spoken of by Mr. Playfair as passed over between *Taunton* and *Honiton*. I had often travelled along this road without seeing any quarries, or having yet had time to make inquiries about them ; this was therefore a point which remained for examination, and it was one of my objects in the following journey.

1887. With regard to the second example, that of the *gravel* of *granulated quartz*, most of the counties in which it is said by Mr. Playfair to prevail were already known to me ; but I had never happened to travel from *Birmingham* to *Bromesgrove*, between which places he speaks of a *rock* of that stone ; this, therefore, was one of my objects, and it was the first that in this journey I went to examine. *Birmingham* had not then sustained the great loss which it has since experienced by the death of Mr.

MATTHEW

MATTHEW BOULTON ; and as my daughter was very intimate with his family, and several others in the neighbourhood, we set out together for that place, whence I purposed to return into *Devonshire*, to my friend Mrs. Burges. It is always interesting to observe the changes of *soils*, when attention is paid, at the same time, to the situations of their *strata*, and to the *gravel*s scattered on their surface ; because these changes add new characters to the revolutions undergone by the bed of the *ancient sea*, before it became our *continents* : I shall, therefore, begin by giving a sketch of such as occur in the road from *Windsor* to *Birmingham*.

*August 10th, 1807.* We set out from *Windsor* in the morning, and proceeded this day to *Oxford*. As far as *Henley*, the base of the soil principally consists in *strata of chalk*, covered with a greater or less thickness of loose strata, the upper parts of which contain a great abundance of *siliceous gravel*. Near *Henley*, the *strata of chalk* are cut off abruptly towards the *Thames*, where they form high hills ; so that, in order to make a good road, it has been necessary to cut very deep into their shattered mass. But after crossing the *Thames* at *Henley*, and entering *Oxfordshire*, the *substrata* are found to consist of a yellowish *lime-stone*, which contains *marine bodies*, very different from those of the *chalk* ; and the fragments of this lime-stone are here the only materials for gravelling the road.

*August 11th.* Setting out from *Oxford*, we continued to pass over hills consisting of *strata* of the yellowish *lime-stone*, without perceiving any sensible change, till we were between *Chapel-house* and *Shipston*. These hills are deeply intersected by vales and combes, which the state of the *strata* shews to have been effects of great catastrophes. For some way, I saw the road gravelled with some fragments of a stone resembling the *blue lyas*; then I observed on it a *gravel* composed of *grey wacke* and *granulated quartz*. The *red strata* begin near *Hockley*, and continue all the way to *Birmingham*: in some places, they are intermixed with *strata* of *bluish marl*; and in general, in this county as well as in *Devonshire*, the *red strata* are alternately *hard* and *soft*: some of them also are *breccias*; but while, in *Devonshire*, the *gravel* of the latter is composed of *grey wacke*, intermixed, as I have described in some places, with masses of *lime-stone*, in *Warwickshire* and the adjoining counties, these *breccias* are formed of the masses of *granulated quartz*, which will now become our object.

From the 12th to the 17th of August, I staid at *Soho*, the house of Mr. Boulton, whence I visited my other friends in the neighbourhood of *Birmingham*, making inquiries, at the same time, respecting the *rock* mentioned by Mr. Playfair, and all the circumstances of the adjacent country; and I learnt that this rock is at the extremity of a great chain of eminences called the *Lickey*, the highest ground within

within a wide extent, the *Lickey beacon*, one of its summits, being seen from a great distance all around: and that the whole mass of these hills consists of *red strata*, among which, as well as in the lower grounds, are those of the *red sand-stone* mentioned by Mr. Playfair; containing more or less abundantly the same rounded masses of *granulated quartz* that form also the superficial *gravel*, with which, like the rest of the country, the whole chain of the *Lickey* is covered. It is at the extremity of this ridge of hills, near the part where it descends to the level of the plain, that the road, having been cut in its foot, the *rock* in question has been laid open to view.

*August 18th.* I set out in the morning from *Soho*; and after travelling nine miles on the *Bromesgrove* road, I came to the point where it has been cut on the foot of the *Lickey*, and found there the mass of *strata* of *granulated quartz* which has been mentioned by Mr. Playfair; its section is of considerable height, and is covered by that of the red *strata* rising thence with the hill, the whole being overspread with gravel of the same nature; but on comparing several masses of this *gravel* which had been broken on the road, with fragments of the stone of the *rock*, I found that they differed greatly in *species*; and I also found great differences in this respect between the separate masses of the gravel.

1388. Such then is the phenomenon of which Mr. Playfair speaks; and when it is observed on the spot,



spot, numberless difficulties arise against the explanation given of it in his work. The mass of *strata of granulated quartz* here appearing externally, is probably an indication that the same *strata* lie under the soil of the country; but no cause is assigned by Mr. Playfair as having acted on the continent since it has existed, which can have broken and scattered so great an abundance of fragments of these strata on the surface of such an extent of country; a part of them in distinct strata, consisting of a soil of a nature absolutely different, and of so great a thickness, that the strata of the stone itself are everywhere, except in the spot above-described, concealed from sight. There is no maxim of greater importance with respect to the interpretation of natural objects, than that cited, at the beginning of this discussion, by Mr. Playfair himself, namely, "That the explanation of a phenomenon should not be sought for from the study of that phenomenon alone, but from the comparison of it with others;" and I shall now apply this maxim to the present case.

1389. Let us then consider what are here the immediate objects. There is first a great extent of country, consisting externally of *strata of sand and sand-stone*, for the most part *red*, the surface of which is covered with a great abundance of rounded masses of *granulated quartz*; and in a particular spot of this country, at the foot of a hill formed of the same soil, some *strata of granulated quartz* have been discovered. Such are the local facts; could

could these *alone* furnish the smallest clue which might lead to any certain determination respecting the nature of the causes that have been here in action? Imagination, indeed, may work on these partial phenomena, when not withheld by such others of the same class as do not allow these effects to be assigned to any cause which has acted on the *continents* since their birth; nor, though Mr. Playfair supposes such a cause, does he explain its nature. With regard to one of the parts of these phenomena, if he had travelled, about thirty years ago, over *Marlborough downs* and *Salisbury plain*, he would have seen the prodigious abundance of large *blocks* of *granulated quartz* then scattered on their surface, (as I have mentioned in §§ 689 and 690); though the whole mass of the hills consists of *strata* of *chalk*, which, towards the sea, rest on *strata* of yellowish *limestone* or of *clay*, and in the interior part of the country, (§ 1379,) on *sandy strata*: in particular, if he had seen on *Salisbury plain* the immense masses of this stone that compose the monument of *Stonehenge*, of which I shall soon have occasion to speak, while all the *gravel* scattered on the neighbouring hills is of flint, and there is no appearance of any *strata* of *granulated quartz* throughout all the southern part of *England*; and if, lastly, he had remarked that, in the counties to which he refers, the superficial masses of *granulated quartz* are associated with *blocks* of *granite* and of *trap*; it could never have occurred to him that these different phenomena, which it is manifest must be  
connected

connected with each other by some common cause, could possibly have been produced on our *continents* subsequently to their birth.

1390. The *strata of breccia* form another essential circumstance of this phenomenon in the counties which we are now considering. Mr. Playfair supposes, that, after the continent became dry, these *strata* were formed on it of fragments of those of *granulated quartz*; and that, by the dissolution of a part of them, the superficial *gravel* was afterwards disengaged. But *breccias* are so general a phenomenon on our continents, that no cause contradictory to what is observed in one country can be ascribed to those of another. It is not enough to assign the *gravel* disseminated over an extensive tract of ground to the decomposition of *strata of breccia* which had constituted its exterior soil; it is first necessary to determine what was the state of the surface whereon these *breccias* themselves were formed and what were the causes of their formation. Now if, without going out of this island, Mr. Playfair had only observed the hills of *breccia* which I have described in *Somersetshire*, (§§ 1351 and seq.) with their *abrupt* sides turned towards low soils of a different kind; the angular motions of their *strata*; the partial subsidences of some of their masses on the sides of fractures, (effects which could not appear externally, unless they had extended down to the lowermost *strata*;) the different nature of the rounded fragments imbedded in their red substance;

the dispersion of *blocks* of this *breccia* over the pouring hills: all these phenomena, I say, fully considered, would have prevented him from saying that the formation of the breccias, pre- and followed by so many catastrophes, can be produced by operations posterior to the retreat of the sea from our continents.

11. *Time* is the resource to which all the resources of such systems, and in particular Mr. Playfair, recur, in order to give plausibility to the suppositions of this kind: he expresses himself in the following terms (p. 117) with regard to the hypothesis that *running waters* have excavated the valleys; and the present subject will afford me an opportunity of examining the argument which he employs. "It affords no presumption," he says, "against the reality of this *progress*, that, in respect of man, it is too *slow* to be immediately perceived: the utmost portion of it to which our experience can extend, is *evanescent*, in comparison with the *whole*, and must be regarded as a momentary *increment* of a vast *progression*, circumscribed by no other limits than the *duration of the world*. TIME performs the office of *integrating* the *infinitesimal* parts of which this *progression* is made up; it collects them into one *mass*, and produces from them an amount greater than any that can be assigned." This is the language of a mathematician, and it therefore flows naturally from the pen of Mr. Playfair; but it is not that

that of a philosopher formed in the school of BACON. In the operations of nature, *Time integrates real effects*; and in rational hypotheses, it can only serve to *integrate possible effects*. Under this point of view, therefore, I shall again examine the hypothesis respecting the *breccias* and *gravels* of the country which has here been our object.

1392. Mr. Playfair himself having cited the above maxim from Bacon, it may justly be asked of him; 1st. What cause, even allowing as much *time* as he can demand, could have brought upon *Marlborough downs* and *Salisbury plain* the immense quantities of large *blocks* of *granulated quartz* which were still remaining there thirty years ago? For this is a circumstance inseparable from the general phenomenon of the dissemination of masses of *granulated quartz* on soils of a different nature.—2dly. In order to produce a dissemination of *gravel* of this species over the great extent of country which he has in view, Mr. Playfair has recourse to the decomposition of *strata* of a kind of *breccia*; viz: of a *red sand-stone* containing this *gravel*: now what cause can he find to have been in action on our continents since their birth, which, within any space of *time*, could not only have broken and reduced into this prodigious quantity of *fragments strata* of *granulated quartz*, supposed to have formed at first the surface of the country, but also have triturated and rounded them, as they are found to have been throughout this whole extent of country? or in the *sand-stone*, or on the surface?  
and

and what cause could afterwards have brought over all this country the immense thickness of *red matter* here extended in *strata*, some of which contain this *gravel*, and others are pure?—3dly. If these various operations could be supposed in any way possible, their production must at least be considered as confined to the lower parts of the country; since it is undoubtedly to *running waters*, though not mentioned by Mr. Playfair, that he ascribes them: what cause, therefore, could have covered with this *gravel* the highest ground in the whole district, that is to say, the *Lickey*?—4thly. All the *strata* of *breccia* in these counties are in many parts *broken off*, and shew their *section* in the sides of the hills, where they are *inclined* towards various points. This is a circumstance to which Mr. Playfair does not advert, but which is common to most *breccias*; so that, according to Bacon's maxim, before he had formed any judgment respecting this phenomenon, he ought to have observed numerous instances of the same class. Now if, without going out of *England*, he had travelled through the southern part of *Devonshire*, the soil of which mostly consists of the same *red strata* containing *gravel* of *grey wacke*, but *broken* into hills, and *inclined* in every direction, the tops and slopes of these hills being also covered with this *gravel*, and with masses of the same *stone*, though no *strata* of it appear in the country;—if he had farther observed the hills of *breccia* which I have described in *Somersetshire*; he would certainly have adopted a different idea; he would have perceived,

I say,

I say, that, since this island has existed, no part of the long succession of operations necessarily required for the production of *breccias* can have taken place on it; and from this single class of geological monuments, he would have comprehended that it is vain to attempt, by imaginary operations, to throw back the *birth* of our *continents* to a period of incalculable antiquity, in opposition to all that results from the attentive observation of the *progress* of real effects produced on them by known causes, which uniformly attest, that no very great number of ages can have elapsed since the *sea* retreated from them into its present bed; an important conclusion, which I have established in the whole course of these Travels by very numerous facts, collected in places where they may have many observers, whenever the importance of verifying the assertions of geologists shall be generally perceived.

1393. After having observed this country, which had been one of the objects of my journey, I proceeded on my way to *Ashfield*, through *Worcester*, *Glocester*, *Bristol*, *Bridgewater*, and *Honiton*. I have already described this road from *Bristol* through *Somersetshire* into *Devonshire*; and though the preceding part of it likewise abounds with interesting objects, I shall omit them, as well as a great many others which I have observed in various parts of *England*, because they would add too much to the length of these volumes; but I derive from them the advantage                    certain, that no phenomena

mena contrary to those from which I have deduced geological conclusions can anywhere be found.

1394. It still remained for me to observe the part between *Taunton Dean* and *Honiton*, where Mr. Playfair asserts that a *lime-stone* is found containing *flints precisely of the same kind* as those that are scattered on the elevated plain of *Blackdown*. No quarries of this kind are within view from the turnpike road, along which I had repeatedly travelled; for this reason, during my present stay at *Ashfield*, I desired Mrs. Burges to make some inquiries respecting them; and she accordingly wrote to the Rev. Mr. LAND of *Hemyoke*, on the northern border of the *Blackdown hills*, who was so good as to enter into correspondence with me on this subject. The object of my inquiries was general; I begged him to inform me of the situations of all the *lime-stone* quarries on the skirts of these hills, known to him either by his own observation, or by the reports of others: he accordingly wrote me an account of several quarries, and among them was that of which, without doubt, Mr. Playfair had heard, though he certainly did not see it; this is situated at the eastern extremity of the *Blackdown* ridge, on a hill called *Blagden*, (a corruption, as is supposed, of *Blackdown end*,) over which passes the road from *Taunton* to *Honiton*: all the other quarries mentioned by Mr. Land are also in *Somersetshire*, and lie to the east and the north of this point. I therefore determined to take the *Taunton* road for my return to *Windsor*.

October



October 29th. 1807. I set out in the morning from *Ashfield*; and after having passed through *Honiton*, and crossed the *Otter* at *Upottery*, I came on the foot of the *Blackdown hills*, which have here the same aspect that I have described in every part of their outline, their slopes being indented with *promontories* and *combes*. I ascended the last of their promontories to the eastward, and found it deeply cut down in many parts to form the road, where nothing appears but *strata* of pure *sand*, above which is seen the section of the superficial soil, composed of an immense quantity of large masses of *flint*, mixed with the vegetable earth produced by the grass and heath growing amongst them. But here, as well as in other places, this original feature of the surface is gradually disappearing, in consequence of the progress of agriculture: when the ground is to be brought into tillage, the first thing that is done is to clear away these masses of flint, which are used for the base of high banks of enclosure, whereon hedges are raised. These soils are then ploughed, and sown with corn, which succeeds very well, and with meadow grass on the slopes, where there is more moisture; so that, on the *Honiton* side, and on the summit, almost all this ground is already become fertile. But on the opposite side the appearance changes: the great *subsidence* which has here produced the wide vale of *Taunton*, and the angular motion of the *strata* remaining on the slope of the hill, have brought new *strata* to view. This slope is so rapid, that in order  
to

to form a good carriage road, it has been necessary to make many windings; where the surface presents sections of *strata* of a *marl* alternately red and blue.

1395. According to the directions which I had obtained to the *lime-stone* quarries nearest to this road, I was to quit it before I came to the village of *Blagden*, and to follow to the west the track of the carts which carry culm to them, and bring back the lime; my postilion shewed me this track; and I quitted the chaise, in order to walk to the spot. Having ascended on the heath, I saw on my left the head of a very deep *combe* descending westwards; along the higher part of the northern side of this *combe* passes the cart-road that leads to the quarries, opened on the upper section of a mass of *lime-stone strata* which form this side of the hill, dipping very rapidly towards its exterior slope, where they are soon lost under the marly soil. The whole outline of this extremity of the *Blackdown hills* bears the characters of a great *subsidence*: it constitutes also the western side of the large *vale* wherein rises the *Otter*; and a part of the *strata* characteristic of these eminences is left on the eastern side of that *vale*. *Yarte combe hill*, which forms the upper part of the latter side, and over which I passed three years afterwards in travelling from *Ilminster* to *Honiton*, is composed of the same *sandy strata*, covered with the same *flints*; but at the foot of both the sides of this *vale*, as well as in several hillocks rising on its bottom, (the remains of the *strata* which subsided in

in this space,) are found the same *strata* of *lime-stone* as in the quarries near *Blagden*: from hence these *strata* extend eastward and northward a considerable way, but are covered with soils of different kinds. But we are now to consider what is the nature of this *lime-stone*, concerning which Mr. Playfair, having certainly spoken of it only from report, has in consequence been led into error.

1396. When I came to the quarries, I saw worked there a mass of *blue lyas*, a kind of lime-stone, which, as I have already said, contains nowhere any *flints*; nor, indeed, did I see here the slightest vestige of them: its *strata* present their section above, and are so much shattered, that they are scarcely fit for any use but to make lime: they have been discovered by some pointed rocks rising above a very thick loose soil. A quarry-man has obtained permission from the lord of the manor to work the ledge of these *strata* which here appears, but on condition of only taking the stone to a certain depth, and then filling up the excavation with earth, and covering it with the turf, taken off and laid aside for this purpose. I distinguished, by the lowering of the surface, the space within which the stone had been already extracted: in the quarries themselves, I saw the *strata* dipping very rapidly inwards; and as I followed the upper part of the slope, I perceived several excavations made in the loose soil, in order to discover the direction of the mass, which is everywhere shattered: the quarry-man has a right

to follow it, as far as he can trace it; but always, as I have said, on condition of covering over with earth and turf the parts whence he has extracted the stone; so that, no indication remaining in future of these quarries, the existence of any *lime-stone* in the *Blackdown hills* might have been unknown to succeeding generations, if this opportunity of commemorating it had not occurred; but now they will also be informed that in this lime-stone no *flints* are contained, although, before these hills were cultivated, vast quantities were spread over every part of their surface. After having observed this place, I went on to *Taunton*, where I passed the night.

*October 30.* I set out at seven in the morning from *Taunton* for *Somerton*, at the distance of eighteen miles: twelve miles beyond the former town, I crossed the *Parrot* at *Langport*. Here I was informed that the tide ascends a mile above the bridge in the channel of the river, which I saw flowing through horizontal meadows, as it does along its whole course; whence it appears how far inland this ramification of the original *bay* extended. The difference between the height of the water at the ebb and at the flow is still two feet at *Langport* bridge; the barges used for the carriage of goods ascend and descend with the tide, and if the wind is contrary, they are moored in the way till the next tide: they bring up hither coals and other articles arriving by sea for the consumption of the country, and carry down trunks and planks of elm and ash; for, in this

part of *Somersetshire*, these trees grow to a large size, and are in great abundance.

1397. After passing *Taunton*, I saw no more *flints* on the road, it being gravelled with fragments of *blue lyas*, of which likewise all the houses are built: the *strata* of the lyas, near *Taunton*, lie under the *red strata*; but as the ground rises, they are found nearer the surface, and at last are covered with only a loose soil, of little depth. There cannot be a more beautiful country than that between *Langport* and *Somerton*; and I understood the cause of this from the difference which I remarked after I passed the latter place: on its western side, notwithstanding the small depth of the superficial soil, there is the finest vegetation of every kind; the orchards of cyder apples are numerous and very beautiful: and the hedges, especially, are remarkable for the large elm and ash trees with which they are all interspersed. But this part of the country is a congeries of small hills irregularly placed, consisting of masses of *blue lyas*, overturned different ways, and all fractured, as is seen in many quarries along the road; so that trees and shrubs thrive here, because their roots insinuate themselves into the intervals and fissures of the *strata* of *lyas*.

1398. The same stony *strata*, and the same superficial soil, continue beyond *Somerton*; but from the difference in the state of the former, a considerable change appears in the aspect of the country. A  
descent

descent here begins towards a large space of low ground encompassed with hills ; but the *planes* of the *strata* of *lyas*, much less fractured, are near the surface ; and the first effect which results from this circumstance is, that the rain waters not being able to penetrate far into the ground, the slopes are wet, and their natural product consists only of rushes and other marsh plants. But the progress of agriculture has led to the discovery of a method of draining soils of this kind ; a method which I have seen practised in other places, and which was now beginning to be employed here. Wide and deep ditches having been made in the direction of the slope, many small trenches descending obliquely towards them are formed in their intervals : when these trenches are marked out, the turf is first cut and taken off, and laid by their side, and they are then dug a foot in depth, the earth taken out being thrown over the adjacent soil ; after this, the trenches are filled up with coarse gravel, or the branches of any kind of tree little subject to decay by moisture, over which the turf is then again laid down. The exterior traces of this operation are soon effaced ; but the effect is already visible the following year ; for the rain waters having a free discharge through the trenches into the ditches, the surface dries, the marsh plants decay, and good meadow-grass springs up in their stead. I saw here all the stages of this process ; some spaces, having already produced hay, now formed good pastures ; in some the trenches were only carrying on ; and in other

parts, the ground was still left to its spontaneous products.

1399. The large basin surrounded by these hills has all the characters of a simple *subsidence*, where the *strata*, in thus changing their level, have sunk on a horizontal bottom, and have consequently undergone but few fractures. The central part of this space, to a great extent, has subsided some feet more than the circumference, which thus forms a horizontal terrace around it. The *strata* of *blue lyas*, still but little below the surface, may here be taken out in flags as large as are wanted, with the advantage common to all strata of this kind, that they are of every degree of thickness, from two to seven inches; which renders them useful for such various purposes, that they are carried to a great distance: they have a very fine grain, and are perfectly parallel with each other; and they have also, as is the case every where, a quantity of small bivalves on their surface, *cardia*, *chamæ*, *mytili*, and *terebratulæ*. Now throughout all this space, as far as the view can extend, no more large trees are seen; because, while the superficial soil continues to have little depth, there are no longer any intervals or crevices in the *strata* of *lyas* through which their roots can insinuate themselves. The orchards however are still very flourishing, apple-trees not having tap-roots; and the grass also is very thick. But it has been necessary to intersect this whole space with drains,

drains, without which it would be nothing but a marsh: in rainy seasons, and during thaws, it is the receptacle of the waters of all the surrounding hills; so that its lower part is then completely inundated, and a small imbankment has been found necessary to secure the cultivated part, which is below the level of these great inundations. I saw, in the sides of the ditches, where the water was then low, that the soil of all the meadows, and even of some of the orchards, had been produced by the sediments of the waters, very abundant before vegetation had covered the hills.

1400. After having crossed this space, which evidently has been produced by a great *subsidence* of the *strata*, and at the extremity of which stands the small town of *Castle Cary*, I found the *strata* of *blue lias* entirely cease: beyond that town, I ascended a road deeply cut in the foot of a hill; and on its sides I saw *strata* of a yellowish calcareous *sand* filled with concretions. From hence to *Wincaunton*, the road, passing over very irregular hills, has been cut down to a great depth in several parts; and sections of the same *strata* every where appear on its sides. There is a great descent towards *Wincaunton*, a part of which town is built on the bottom of the slope; but the most considerable part rises up the side of a small hill opposite. I staid here the remainder of the day, in order to observe the surrounding country.

1401. With this view, I first walked down to the spot



the broken masses that remained at a higher level than the rest in the great *subsidence* whence this plain resulted ; their intervals having been levelled by the first sediments of the brooks, now covered with meadows. The nature of these small scattered *mounts* continues the same as far as *Mere* ; but beyond this, though the plain extends for some way, and is still interspersed with *hillocks*, the latter are formed of *strata* of *chalk*, as yet containing no *flints* ; this chalk is of the same kind as is found at the foot of the large hills which rise to the eastward, and is hard enough to be used as hewn stone for building houses, where it becomes grey by exposure to the air.

1403. Let us now stop, for a moment, to consider the variety of the *strata*, all homogeneous in their very distinct species, which succeed each other from *Honiton* hither, within a space of about sixty miles in extent. In setting out from *Honiton*, the road passes over the *Blackdown* hills, composed of *strata* of *sand* and *sand-stone*. From the extremity of those eminences on the *Taunton* side, to *Castle Cary*, prevail the *strata* of *blue lyas*, covered at first with those of the *Blackdown* hills, then with *red strata*, and at last with only a thin superficial soil ; in the western part of this tract, composing irregular hills, and then forming a vast space of low ground, beyond which rise hills consisting of *strata* of yellowish *lime-stone* incompletely consolidated ; the latter continue likewise through a great extent of low ground, wherein, at the same level, they are succeeded

ceeded by *strata of chalk*, which afterwards rise into hills. If the geologists, who have supposed our *mineral strata* to have been formed of the *detritus* of antient continents carried down by rivers into the sea, had fixed their attention, on one hand, upon the nature of the *sediments* formed by those streams on the coasts, consisting always of a *mixture* of particles of all the kinds which the branches of the rivers have brought down in their course through different soils; and, on the other, upon the variety of the *strata*, of very distinct species, which succeed each other in so many parts of the continents, within spaces of such small extent; this idea could never certainly have occurred to them, nor could the Huttonian theory, of which it is the foundation, have ever been imagined.

1404. The *chalk* hills, which begin here, extend their branches over a great extent of the southern part of *England*: their spontaneous product is only a thin turf, formed on rubbish of *chalk* intermixed with flints; agriculture is beginning to overspread them; but their aspect, even when cultivated, is very different from that of the preceding hills, and much time and a great deal of manure are requisite for the production of a good soil upon them; no tree grows here, nothing being seen but a few bushes of white thorn, much stunted, especially because the sheep are constantly browsing on their tender branches. But it is not the same in the deep inter-sections of these hills where small streams flow; a very

very good soil, produced by the sediments of the rain-waters having been formed on their bottom ; this soil is covered with meadows, and planted with trees along the course of the waters ; and these are the situations in which are placed the villages of the new settlers, who are extending cultivation over the hills, and whose cottages are surrounded with gardens and orchards. I came to one of these villages after I had passed *Hindon* ; but the most considerable vale is that wherein *Deptford Inn* is situated ; and its bottom is covered with very fine meadows, along the small river *Willey*, which, flowing towards *Salisbury*, unites with several similar streams to form the *Avon*. The hills bordering these vales, shew the influence of the neighbourhood of meadows where cattle are kept ; these hills, though their soil is the same as that of the rest, having made a much greater progress in fertilization.

1405. From *Deptford Inn* I took the road to *Amesbury*, in order again to observe the stupendous druidical monument called *Stonehenge*, which is near that town : so many conjectures have been formed respecting its origin, that the time when it was constructed cannot with any certainty be determined ; but, as a geological monument, it belongs to the number of those which the most evidently attest how little change has been undergone by the surface of our continents, since they have been abandoned by the sea. The masses of *granulated quartz* which compose *Stonehenge*, and which have been respected by  
builders

builders on account of their remarkable arrangement, are the largest of those that were scattered over this part of the *chalk* hills. The principal part of these masses are from twenty-eight to thirty feet in length, and about seven in breadth, with a considerable thickness. It is surprising how, at a time whereof we have no memorials with regard to the state of the mechanical arts, the first inhabitants of the country could have constructed this kind of edifice, the nature of which may be understood by the part still standing: it consisted of three concentric circles formed of these immense stones, placed like columns at some distance from each other, and connected together at the top by transversal pieces of equal size. It is this latter part of the edifice which is the most astonishing; for it is not conceivable how, without the assistance of machines not known by any tradition to have existed here at that period, such masses could have been raised up and fixed at that height: in those that have fallen is seen the mode of their connexion with the upright pieces; at the top of the latter, there are on each side hemispherical projections, which being fitted into corresponding cavities at the opposite extremities of the architraves, the latter are thus secured from any lateral motion.

1406. The difficulty of comprehending how the early inhabitants of the country could have, not only constructed such an edifice, but brought these enormous masses from any distant place, has given rise to

to a singular idea. At the side of a map of *Wiltshire* by EMAN. BOWEN, it is said, "that *the conjecture seems to be well founded* which supposes "them to be artificial stones, made of *sand and some glutinous matter cemented together.*" Had this geographer been a lithologist, he would have easily distinguished this natural stone from an artificial one; and had he been an observer of the country, where masses of the same kind are scattered in such astonishing abundance over the neighbouring hills, he might have comprehended that these which compose *Stonehenge* were probably found on the very hill where they were employed in forming this fabric. That such masses should be found here cannot appear surprising, after the account which I have given in the first Vol. of these Travels of much larger masses of *granite* scattered on the sandy hills of *Holstein*; and on the tops of some hills in other parts of the north of *Germany*, I have seen enormous granitic masses arranged in a different manner, but certainly intended, as *Stonehenge* has probably been, for places of worship; for near them have been found the instruments of sacrifice, axes, and knives made of *flint*; and around them are every where seen some of the *tumuli* known in *England* by the name of *barrows*; which were the tombs of the persons of the highest distinction in those distant ages.

1407. From *Stonehenge* I descended to *Amesbury*, a small town situated at the foot of the great *chalk* hills on this side; and hence I proceeded to  
*Overton*

*Coerton* and *Basingstoke*, through a country interspersed with low hills of the same nature, of which the mass is so much shattered, that wherever the *chalk* appeared, I saw it in small fragments. The external signs of *chalk* disappear on the road towards *Hartford Bridge* and *Bagshot*, at the latter of which places I spent the night. The hills here consist of *strata* of *sand*, either pure or argillaceous, covered with a great abundance of *siliceous gravel*, and their spontaneous product is only heath, with the plants which usually accompany it. Since I have lived at *Windsor*, cultivation has made great progress in this country, and vast quantities of *blocks* of *granulated quartz* have been taken out of the superficial soil, and employed for various purposes.

1408. In the soil of this country, there are also buried large masses of *chalk*: I have seen many places in which such masses, insulated in the sand and gravel, have been exhausted, after having been worked a long time for the purpose of making lime. The hill on which *Windsor Castle* is built is the largest of these masses in the country; its *strata* are cut off abruptly towards the *Thames*, and the rapid slope of the hill on that side is composed of their rubbish; they are inclined towards the opposite side, and are lost beneath the *strata* of loose soil; but other masses are found here and there, in the same direction, buried under this soil. These are monuments of the cause to which I have assigned the immense quantity of *siliceous gravel* disseminated over

so many countries where no *chalk* appears externally, though the flints scattered here were undoubtedly formed in *chalk*; for not only do they contain the same *marine bodies*, chiefly *echinites*, but when these flints are broken, *chalk* is often found within them, as I have seen in those which are scattered over the sandy hills of the country of *Bremen* and elsewhere. All the phenomena of this kind detailed either in my first geological work, or in these Travels, lead, as I have already explained, to the conclusion, that, at a certain period of the chemical operations in the ancient sea, large masses of *chalk* were dissolved in its liquid, the *flints* of which masses were scattered over its *bottom*, antecedently to the period when the latter, by the retreat of the sea into its *present bed*, became our *continents*.

*November 1st.* I arrived at *Windsor* in the morning, thus terminating my last geological excursion. It was time that I should put an end to these Travels, which I had begun nearly sixty years before; for I was now far advanced in my 81st year. However, as a little travelling in the summer agrees with my health, I have again returned twice into *Devonshire*, taking each time a different road, both in going and returning, in order to become still better acquainted with a country, which, as may have been judged, is very fertile in geological phenomena. As however, in general, these roads present only varieties of the same phenomena, I shall describe but one of them, in which some new circumstances will appear.

1409. In relating my journey in October, 1805; I have described the chain of the *Mendip hills* in *Somersetshire*, from its western extremity terminating at the sea, to its deep intersection by the valley in which the city of *Wells* is situated; speaking particularly of the connections of the southern slopes of this chain with the meadows occupying the original bay of *Bridgewater*. The account of my journey in August, the following year, contains details respecting the nature of the soil of a great part of this space, and the monuments which indicate the progress of its filling up. But, as nothing more essentially contributes to the establishment of solid bases in the *history of the earth* with regard to the points whereon any controversies still subsist, than complete description of particular assemblages of phenomena belonging to certain general features of the *continents*, it had been my wish to proceed along the head of this ancient bay, and thence to pass over the prolongation of the *Mendip hills* on the eastward of the valley of *Wells*, in order to follow that chain to the point where it terminates in the interior part of the country, and to observe the transition from its *strata*, which are of a remarkable nature, to those already known to me on that side. This was the motive that determined me to take the road, a part of which I am now going to describe.

*October 11th, 1809.* I set out from *Ashfield* at eight o'clock in the morning for *Taunton*, whence I intended to follow, along the meadows, the extremities



ties of the hills descending to the ancient *bay* of *Bridge-water* as far as their northern part, which joins the chain of the *Mendips* near the point where *Glastonbury hill* rises above those meadows. I have already described the road from *Honiton* to *Taunton*<sup>1</sup>; I shall now therefore begin only from the latter place.

1410. For some way I proceeded along the *Bridge-water* road: then turning to the N.E. I followed a promontory of the *original soil*, composed of the common *red strata* intermixed with others of *red sand-stone*, which, advancing into the meadows, separates those of *West Sedgemoor*, extending all the way to *Langport*, from other meadows wherein the *Parrot* afterwards flows. I then descended into the latter meadows, and crossed the river at *Borough bridge*, a place ten miles distant from *Taunton*, adjoining to an eminence of the *red strata*, which, being completely insulated in the meadows, was certainly an *island* in the ancient *bay*: a chapel having been erected on the summit by a gentleman in the neighbourhood, who died before it was finished, this eminence is indicated in the maps by the name of *Borough Chapel*.

1411. Hence I followed, through the meadows of *King's Sedgemoor*, the borders of the *original coast*; passing over several of its promontories, no longer composed of *red strata*, but *grey*, and covering *strata of blue lias*; in the first of the promontories, the latter appear only at the level of the meadows, which

was that of the sea in the original *bay*; but, in consequence of the catastrophes of all the *strata* at the formation of the bed of the sea, these of *blue lias*, much interrupted, are seen to rise farther to the eastward, and at last come up to the surface near the beginning of the long promontory of *Polden hill*, of which I have given a circumstantial account in my preceding travels. Crossing this promontory, I came to *Heath moor*, where I found the *Brue* flowing through meadows which almost entirely surround two eminences; and on the base common to both of these is placed the small town of *Glastonbury*: they are in the form of cones, the easternmost, called *Glastonbury Tor*, being considerably the highest; and on the summit of each rises an ancient tower. These united eminences formed very nearly an *island* in the ancient *bay*, being on all sides encompassed with meadows, except at one point of their base, where the road which I followed passes over a very low and narrow slip of the *original soil*. Hence I proceeded to *Shepton Mallet*, where I spent the night. This town stands on the hills bordering the low part of the chain of the *Mendips*, which extends towards the east; and on the sides of the road I saw appearing here and there the *strata* of the *blue lias*.

*October 12th.* About seven in the morning I set out from *Shepton Mallet* for *Frome*, at the distance of twelve miles. After having ascended for some time, I came to the village of *Doulting*, where I

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saw quarries, which, from the extent of the excavation, must have been worked for a long time; they are in very regular *strata* of a good building stone, which appeared to me to be a *sand-stone*. But when, after having passed a slight inflexion of the slope, I ascended the highest part of this ridge, I found there the same hard reddish *lime-stone*, properly a kind of *marble*, which composes the *Mendip hills*. I saw quarries of it at the village of *Chelynych*, where these *strata*, very much inclined, have visibly participated in the catastrophe whereby the *strata* of *sand-stone*, here formed upon them, have been thrown down on the sides of the ridge, in the same manner as the catastrophes of the calcareous strata were shared by the loose *sand* on the great eminences which I have described to the westward of *Wells*. As I proceeded along the top of these hills, where the lime-stone of the *Mendips* still appeared for some way at the surface, I learnt from my driver that the same *sand-stone* which I had seen on the southern slope is also found on the northern; and that, at a lower level, lies a bed of *coal*, which is worked at *Stoke-lane*, *Leigh*, and other places in the neighbourhood.

1412. In following the hill on the *Frome* side, I saw nothing more of the *strata* of the *Mendips*, but some rocks rising up to the level of a very deep soil of yellowish argillaceous sand; and from these rocks is taken the stone which is broken to gravel the roads. Farther on, this extremity of the *Mendip hills* is indented with very deep *combes*, of sufficient extent to  
have

have brooks flowing in them, and separated by ridges of hills; the latter being masses of strata divided by the large longitudinal fractures which produced the *combes*, all inclining towards the side where the greatest *subsidence* took place; a character that I have already elsewhere described. Hence, each of these *combes* has one of its sides very steep, and covered with wood, as being that which presents the *section* of the *strata*, and into which the roots of the trees can therefore easily penetrate: all these *sections* are turned towards the same point, and the opposite sides of the *combes*, being formed by the *planes* of the *strata*, are covered with grass, or cultivated. The town of *Frome* is built on the extremity of one of these ridges, which descends with considerable rapidity towards a narrow vale, wherein a river of the same name flows northward to join the *Avon*. Now at this base of the eastern extremity of the *Mendip hills* is found the same yellowish *lime-stone* irregularly concreted, which I have described to the southward in the hills near *Wincaunton*, and to the northward in the neighbourhood of *Bath*; and at a little distance from *Frome*, on the latter side, are found also *calcareous strata* of the kind called *free-stone*, on account of the facility with which it may be cut and sawn.

1413. Hence I proceeded towards *Trowbridge*, ten miles distant. The road passes over several small hills, which, as well as the lower grounds between them, are covered with a very thick argillaceous soil; so that I did not any where perceive

stony strata ; but these must appear at the surface somewhere in the neighbourhood, for the road was gravelled with fragments of the concretions which are common in the *strata* of this yellowish *lime-stone*. When I came to *Trowbridge*, I found the fronts of the houses there built of *free-stone* ; most of them in a style of very elegant architecture.

1414. I next proceeded to *Devizes*, at the distance of ten miles. Within the space of the first six of these miles, the soil, by its horizontality, has an appearance similar to that of the plain which I have described between *Somerton* and *Castle Cary* ; but the difference of the bottom is shewn by the trees. In the latter plain grow scarcely any elms, because, as I have said, its bottom is formed by the *planes*, very little fractured, of the *strata* of the *blue lias* ; whereas in this of which I am now speaking, the bottom consisting of *lime-stone strata* imperfectly concreted and much broken, these trees flourish in great abundance. About four miles before I came to *Devizes*, I crossed another ridge of hills composed of *red strata* still intermixed with *strata* of *sand-stone* of the same colour. Beyond this, I saw the road gravelled with *lime-stone* of a different species, greyish, and harder than the preceding ; and on my inquiring whence it was brought, I learnt that it was found at the surface near *Chippenham*, two miles from hence on the river *Avon*.

1415. Nearer *Devizes*, I ascended the foot of the *chalk hills*, the slopes of which are cultivated ; but  
their

their summits are still downs : their base consists of the kind of *chalk* containing no *flints* ; and it is hard enough to be broken for the purpose of mending the road, mixed with gravel brought from some other place. From *Devizes* I went towards *Marlborough*, fourteen miles distant. On all the heights, I saw the soft *chalk* that contains *flints*. In their intervals lie small vales, wherein flow rivulets, along the course of which there are always meadows ; in these parts the villages are situated ; and the adjoining slopes are cultivated. As I approached *Marlborough*, I took particular notice of the state of agriculture ; and I was surprised at seeing what progress it had made since 1805, when last I had passed this way ; the ground was now all enclosed, and the *blocks* of *granulated quartz* had entirely disappeared. It will therefore be of advantage to future geologists, and especially to those who may pay any attention to *Stonehenge*, that an account has been given of the quantity of these *blocks* still scattered here not more than thirty years ago, and of the progress made since that time by agriculture, which has thus occasioned their disappearance.

1416. From *Marlborough* I proceeded to *Hungerford*, ten miles distant. On entering *Savernake Forest*, I no longer saw any appearance of *chalk*, it being succeeded by the soil which is common to all the hills and plains to the eastward, that is to say, *sand*, either pure, or mixed more or less with clay, the surface being covered with siliceous gravel. I  
arrived

arrived at *Hungerford* at seven o'clock, and spent the night there.

*October 13th.* *Hungerford* is only a village situated on the borders of large meadows on peat, through which passes the canal already mentioned as carried on across the southern part of *England*, and forming a communication between the *Thames* and the *Avon*. Here, as I said before of similar soils near *Reading*, the sand on which the peat lies, being penetrated with it, is burnt in heaps, in order to be scattered over the lands. From this place I proceeded to *Newbury*, at the distance of nine miles, and then to *Reading*, seventeen miles farther. The plain over which the road passes in the latter stage, though but little higher than the peat meadows, here occupying large spaces, is of a very different soil; that of the meadows, always overflowed in rainy seasons, and when the snows are melted, has been levelled by the action of these waters, and by their sediments; but that which is above the level of the inundations is the original soil, every where consisting of sand more or less argillaceous, with *flints* scattered on its surface: there are hillocks here and there, whence this gravel is taken to mend the road, and where its stratum is sometimes four or five feet in thickness: the *flints* are small, and very different from those found in most of the *chalky strata* which still exist.

1417. From *Reading* to *Maidenhead*, thirteen miles distant, there is again a large plain consisting of

of the same soils ; but *strata* of *chalk* are found here and there near the surface, and this *chalk* is taken out to be spread on the arable lands, mixed with the sediments of the water in the ditches by the sides of the fields ; it differs in different places, being sometimes the soft *chalk* containing *flints*, which, as I have pointed out in several instances, forms the upper part of the chalk-hills. Here the hills are on both sides at a great distance from the road ; those to the N. W. which are of *chalk*, extend from near *Maidenhead* towards *Henley* ; and masses of *chalk* are found here and there in the low grounds as far as *Windsor*, as I said at the end of my last journey.

CONCLUSION.



## CONCLUSION.

SINCE the year 1779, when I published my first geological Travels in my *Lettres sur l'Histoire de la Terre et de l'Homme*, I have made many more, in various countries, to which, though their publication has been delayed by different causes, I have been obliged to refer in several subsequent works; viz. my Letters to Dr. Hutton, inserted in the *Monthly Review*, those to M. DE LA METHERIE, in his *Journal de Physique*, those to Professor BLUMENBACH, which were first published in the *British Critic*, and afterwards in an enlarged edition at *Paris*, and lastly, my *Elementary Treatise on Geology*, published both at *Paris* and in *London*.

In the exposition of a system of such vast extent as to comprise all the principal physical events that have taken place on our globe, together with their causes, the propositions of which it is composed would be thrown to too great a distance from each other to be embraced, both in their aggregate, and in their relative connexions, if they were accompanied, at every step, with circumstantial proofs, whether of the existence of monuments of effects which had been produced during certain periods, or of the physical and mechanical principles which lead to a determination of the causes of such of these effects

effects as have now ceased. For this reason, I employed, in the above mentioned publications, only the general results of observation and experience, referring to future works the proofs of these results; except so far as concerned the geological monuments observed in great chains of mountains, respecting which M. de Saussure's *Voyages dans les Alpes* supplied me with essential facts, of which the truth is known to me by my own observations, both in the *Alps* themselves, and in other mountains of the same class.

With regard to the physical objects belonging to Geology, I have fulfilled my engagement to the public in my work intitled *Introduction à la Physique terrestre*, and in other works connected with that, especially several papers presented to the Royal Society. But my engagement with respect to my Geological Travels required a much longer time; as I had to arrange the observations which were contained in my numerous journals. On this subject I must here make a remark, in order more particularly to account for my having at present published only the latest of these Travels.

When geological researches were first undertaken, which was not till a very late period, it appeared to be necessary, for the purpose of rightly understanding the events which had taken place on the earth, to seek for monuments of those events in very distant  
 tant

as in mountains, only on a smaller scale; and with regard to the coasts, if attention be paid to the actions of natural causes on them, there are few of any extent, where examples of the real operations of the waters of the sea and land may not be found. As for my choice of the particular countries in which I made these my latest travels, Mr. Playfair's work having served me as a text, in my *Elementary Treatise*, for the introduction of the most important geological questions, it naturally determined me in favour of the places observed or referred to by himself.

: The remarks dispersed throughout these Travels have had one general object, of which I have endeavoured to render manifest the importance. Most of the errors contained in geological systems are derived from one common source; namely, that, in the descriptions there given of natural phenomena, the effects operated on our *continents* previously to their *birth*, by causes which since have ceased to act, are confounded with those that known causes have produced and are continuing to produce on them. This is the object with which is connected the geological question of the greatest importance to the whole human race; namely, from what *period* have our present *continents* existed? When certain operations antecedent to the existence of these continents are ascribed to the various causes which are now in action on them, it appears no less impossible to set any bounds to their *antiquity*, than to that assumed by the fabulous dynasties

dynasties of the Egyptians, and of some of the Asiatic nations. But, throughout the whole course of these Travels, I have demonstrated that this is an error, dissipated by the progress of geological researches; and that, when the real effects produced by the only agents which, since the birth of our *continents*, have acted, and can act on them, are carefully studied, it is in fact impossible to carry back their *origin* to a period more remote than that which the Mosaic chronology has assigned to the deluge.

Though I have not introduced this great point into any of my discussions, I thus conclude by affirming it; because it cannot now be reasonably contradicted, until all the facts accumulated in these Travels shall have been disproved, and contrary ones established in their room. But after so long a time as I have devoted to observations in very different countries, I am well assured that such a refutation is impossible: and this will be farther seen in the account of some earlier travels, partly among great mountains, and partly in other countries of hills and plains, which I have begun to prepare for publication. The first of these will be found to confirm all the important remarks that I have hitherto introduced on the authority of M. de Saussure, though at the same time I shall be obliged to point out some errors into which that great observer of the *Alps* occasionally fell, from not having extended his researches into many countries of hills and plains; and

- Berry Pomeroy, § 1324.  
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 Buckerell Knapp, § 948.  
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## C.

- Camel R. §§ 1093—1096, 1109—1111, 1113.  
 Carn R. § 1147.  
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 Clyst R. §§ 1342, 1343.  
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## D.

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 1047, 1048, 1050, 1051, 1054, 1055, 1076, 1324.  
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## E.

St. Earth, § 1217.  
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 Erme R. § 1320.  
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**Exmouth**, § 1009.

## F.

**Fal R.** §§ 1129—1131, 1135, 1136, 1138, 1269, 1271.  
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**Fowey**, § 1300.  
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**Frome**, § 1412.

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**Gampton**, § 1023.  
**Gerrans bay**, §§ 1272, 1273, 1298.  
**Glastonbury**, §§ 1374, 1411.  
**Godolphin hill**, §§ 1215, 1236, 1245.  
**Grampond**, §§ 1136, 1269.  
**Gulvall**, §§ 1193, 1196.  
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## H.

**Haldon hills**, §§ 943, 1025, 1331, 1344.  
**Hamoaze**, §§ 1087, 1317.  
**Hartridge hill**, § 948.  
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**Helstone**, §§ 1236, 1239, 1243—1245.  
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**Hembury Fort hill**, §§ 948, 953.  
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## N.

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- Tale R.** § 1344.  
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**Tavistock,** § 1076.  
**Tavy R.** § 1076.  
**Taw R.** §§ 1076, 1077.  
**Teign R.** §§ 1018, 1056, 1069, 1076, 1331—1334, 1337.  
**Teignmouth,** §§ 1016—1018, 1325.  
**Thames R.** §§ 1380, 1382, 1387, 1408.  
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**Tinhay R.** § 1086.  
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# TABLE

OF THE

## GEOLOGICAL FACTS

*Described in the Three Volumes of these TRAVELS, arranged under the HEADS of the INTRODUCTION which they respectively tend to illustrate; with references to the Volumes and Sections.*

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### HEAD I.

“ Since the opposite sides of many *Vallies* are formed of different Substances, these *Vallies* cannot be attributed to the action of *Rivers*, cutting through a continuous mass.”

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#### *Differences of the Strata on the opposite Sides,*

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Of a combe in *Torbay*, II. § 804.

Of the valley of the *Dart*, II. §§ 821, 823. III. § 1054

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 ——— of the *Otter*, III. §§ 969, 1002.  
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 Of a vale near *St. Columb*, III. §§ 1120, 1121.  
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 ——— of the *Hel*, III. §§ 1261, 1262.  
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## HEAD II.

“ The difference between the *Gravels* on the heights and on the  
 “ declivities of the opposite sides of *Vallies*, and that be-  
 “ tween those *Gravels* and the *Stony Strata* which border  
 “ them, are also in contradiction to this Hypothesis.”

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- In the *siliceous Gravel* on strata of *lime-stone, argil, and marl*,  
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In the *siliceous gravel* on the hills of *Widworthy* and *Offwell*, spread over strata of *loam*, which cover *lime-stone*, containing no *silex*, III. § 969.

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### HEAD III.

“The differences between the opposite sides of *Vallies*, in  
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*This proportion is shewn not to exist between*

- The vales of *Holstein*, and their streams, I. § 349.  
 The *Bredy*, and its vale, II. § 536.  
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## HEAD V.

“ The opinion that *Vallies* have been excavated by *Rivers* is  
 “ also opposed by the great differences of *Declivity* in the  
 “ same valley.”

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II. §§ 854, 873.

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## HEAD VI.

“The *Widenings* and *Contractions* of *Vallies*, are also a cir-  
“cumstance absolutely contrary to this Hypothesis.”

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### *Such variations of breadth described*

In the vale of the *Swentin*, I. § 340.

In vales of *Holstein*, which thus admit of the formation of arti-  
ficial lakes, I §§ 346, 349.

In the vale of the *Bredy*, II. § 536.

————— of the *Wcy*, II. §§ 572, 574.

————— of the *Froome*, II. § 675.

In the combe in which *Kingswear* is situated, II. § 806.

In the valley and æstuary of the *Dart*, II. 817—820, 824.  
III. §§ 1025, 1030, 1039, 1047, 1050, 1054.

In the valley of the *Tamer*, II. §§ 866—868. III. §§ 1087,  
1317.

In the defile of the *Cheddar cliffs*. II. § 914.

In the valley of the *Ax*, III. §§ 983, 984:

In the combe of *Branscomb*, III. § 998.

In a combe opening into the æstuary of the *Dart*, III. § 1023.

In the valley of the *Lyd*, III. §§ 1082—1084.

————— of the *Camel*, III. §§ 1094, 1095.

In the gulph of *Falmouth*, III. §§ 1131, 1137, 1138.

In the valley of the *Loe*, III. § 1242.

In the valley and gulph of the *Fowey*, III. §§ 1296—1300.

In the valley of the *Teign*, III. § 1337.

————— of the *Tone*, III. § 1349.

HEAD

## HEAD VII.

“The *Aquatic Plants*, which grow on the *Beds of Rivers*,  
 \* shew directly that no erosion takes place there.”

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*Examples of this are given*

In the aquatic plants on the bed of the *Swentin*, I. § 323.

————— of the *Froome*, II. § 589.

————— of the *Ax*, III. § 992.

————— of the *Dart*, III. § 1047.

In the moss on the bed of the brook forming the cascade near  
*Lidford*, III. § 1084.

————— on the granitic blocks on the bed of the *Erme* at  
*Irybridge*, III. § 1320.

————— on the stones on the bed of the *Aven*, III. § 1322.

————— on the blocks at *Beckey fall*, III. § 1335.

In the grass on the bed of a brook at *Wincaunton*, III. § 1401.

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 HEAD VIII.

“*Running Waters*, far from having produced the *Excavation*  
 “ of *Vallies*, have in many places raised them to a higher  
 “ level than they originally possessed.”

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*This effect shewn*

In the meadows bordering the *Havel*, I. § 137—140.

————— near *Strelitz*, I. § 149.

————— of a vale near *Wismar*, I. § 261. a.

In the vale of the *Oder*, I. § 278.

————— of the *Trave*, I. §§ 302, 305, 306.

————— of the *Schwartau*, I. § 306.

- In the vales of *Holstein*, I. §§ 350, 357.  
 In the vale of the *Elbe*, I. § 388.  
 ————— of the *Char*, II. § 558.  
 ————— of the *Wey*, II, § 572.  
 ————— of the *Stour*, II. § 590.  
 ————— of the *Avon*, II. §§ 727, 732.  
 ————— of the *Dart*, II. § 818. III. §§ 1030, 1031, 1039,  
 1048, 1050, 1054.  
 ————— of the *Ax*, III. 940, 983, 984.  
 ————— of the *Yarte* and the *Cory*, III. §§ 975, 982,  
 984.  
 ————— of the *Otter*, III. §§ 1001—1005, 1346.  
 ————— of the *Tamer*, III §§ 1086, 1087.  
 ————— of the *Camel*, III. §§ 1094, 1095.  
 ————— of the *Fal*, III. §§ 1269, 1270.  
 ————— of the *Fowey*, III. § 1297.  
 ————— of the *Seaton*, III. § 1306.  
 In the vallies of *Dartmoor*, III. §§ 1323, 1336.  
 In the meadows of the *Ex*, III. 1326—1330, 1340—1342.  
 ————— of the *Tonc*, III. § 1349.  
 In a succession of low vallies across the southern part of *Eng-*  
*land*, III. § 1382.  
 In meadows near *Wincaunton*, III. §§ 1401, 1402.  
 In the vales of the chalk hills in *Wiltshire*, III. §§ 1404, 1415.  
 General result of these observations, I. § 373. III. §§ 1309,  
 1310.

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## HEAD IX.

“Lakes also oppose an absolute barrier to this system.”

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### *Descriptions*

- Of the lakes of *Furstenburgh*, I. §§ 144—147.  
 Of *Tollenser-see*, I. § 152.

Of *Zierke-see*, I. §§ 154—182.

Of some small lakes, near *Zierke-see*, almost filled up with peat, I. §§ 173, 188—190.

Of *Malchinsche-see* and *Cummeroische-see*, I. §§ 194—201.

Of a lake near *Tcterow*, I. § 208.

Of some lakes near *Strelitz*, I. §§ 212, 214.

Of the lake of *Schwerin*, I. §§ 259, 260.

Of a lake near *Wismar*, almost filled up with peat, I. § 261.

Of the successive lakes of *Eutim*, *Keller*, *Ploen*, and *Preetz*, I. §§ 311, 313, 314.

Of the limpidity of the *Swentin* on issuing from these lakes, I. §§ 323, 338.

Of the lakes along the course of the canal from *Holtensau* to *Tonningen*, I. §§ 356, 357.

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## HEAD X.

“ The successive differences in the *Gravel* in the beds of such  
 “ *Rivers* as flow in Plains, after quitting *Mountains*, prove  
 “ that the Materials, which once filled the vacancies of the  
 “ latter, have not been *carried away* by those streams.”

The countries described in the present Travels afford but few examples of this Head, as they do not contain any great *Rivers* which flow in plains, and have their beds covered with *Gravel*; but several instances of it will be found in the Travels which Mr. DE LUC is now preparing for publication. One example, however, is here mentioned in *Switzerland*, I. § 252; and another may be pointed out in *England*, which will give an idea of the general case; namely, that of the *Ycalm*, which, at a small distance from *Dartmoor*, whence it proceeds, has its bed covered with a gravel, evidently not brought down from that ridge, but of the same kind that is contained in all the bordering hills, from the feet of which it is detached, when they are attacked by the river during floods: III. § 1322.

## HEAD XI.

## HEAD XI.

"Characteristic Differences between *Alluvial Grounds*, and  
 "such *Gravelly Soils* as are out of the *courses of Rivers*."

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*Description of the ALLUVIAL SOIL*

Of the *Havel*, I. § 140.

Of the *Froome*, contrasted with the *gravelly soil* of the hills, II.  
 §§ 589, 590.

Of the *Dart*, III. § 1030.

Of the *Loe*, III. § 1242.

Of the *Èx*, III. § 1327.

Of the *Otter*, III. § 1345.

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*Of GRAVELS out of the course of any RIVER,*

On the hills bordering the *Chesil bank*, II. §§ 505, 516, 526.

On sandy hills in *Berkshire*, III. §§ 1407, 1408, 1416.

In beds in the *Isle of Wight*, II. § 620:

~~\_\_\_\_\_~~ in the cliffs at *Budleigh Salterton*, III. § 1007.

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HEAD XII.

"The *Blocks of Stone* scattered over our *Continents* cannot  
 "possibly have *migrated* on their surface."

---

*This evidently appears with respect to*

The blocks of *Granite* on the tops of hills near *Strelitz*, I. § 150.

~~\_\_\_\_\_~~ lying in vast abundance near *Lambrechts-*  
*hagen*, I. § 253.

The blocks of *granite* near *Lubeck*, I. §§ 301, 303.

————— of extraordinary size near *Eutia*, I. § 309.

————— in abundance near *Husum*, I. § 383.

————— on high grounds in *Cornwall* similar to *Dartmoor*, III. §§ 1088, 1092.

————— on a hill near *St. Columb*, III. §§ 1121, 1122.

————— near *Penryn*, III. §§ 1262, 1264.

————— near *Lostwithiel*, III. § 1296.

————— and other *primordial Stones* covering a large space near *Liepen*, I. §§ 190 a.—192.

————— on *Dartmoor* II. §§ 783, 784, 788, 789, 863—866. III. §§ 1038, 1040, 1041, 1049, 1058, 1062—1069, 1072—1074, 1080, 1334—1337.

The blocks of *granulated Quartz* in various parts of *England*, II. §§ 688—690. III. §§ 1405, 1406, 1415.

————— of *sand-stone* near *Dorchester*, II. § 528.

————— of *serpentine* near the *Lizard point*, III. § 1246.

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### HEAD XIII.

“Some *Vallies* parallel to the *Coasts*, by which *Streams* arrive  
“at the *Sea*, are also contrary to the *Hypothesis* of the Ex-  
“cavation of *Vallies* by *running Waters*.”

---

*Examples of this phenomenon appear*

In a vale in the *Isle of Wight*, II § 612.

————— near *Sidmouth*, II. § 765.

————— near *Helstone*, III. §§ 1238, 1243.

In several combs near *Shaldon*, II. § 793. III. § 1018.

In a combe descending from *Marlborough* to *Salcomb*, II. § 833.

———— near *Roscarrock*, III. §§ 1097, 1098:

———— behind *Castle Trereen*, III. §§ 1186, 1192.

———— near *Mevagizey*, III. §§ 1274, 1275.

In *St. Mawc's creek* in the gulph of *Falmouth*, III. § 1138:

In a creek opening into the gulph of the *Heyl*, III. § 1219.

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#### HEAD XIV.

“ Many Rivers which, before they arrive at the Sea, discharge  
 “ themselves into *Gulphs*, shew particularly, at that end of  
 “ their course, that they have not dug their own channels.”

—◆—

*This is evidently the case with*

The *Warnow*, in the gulph of *Rostock*, I. §§ 226, 227, 232, 237.

The *Trave* in the gulph of *Lubeck*, I. §§ 292—294, 299, 300:

The *Swentin* in the gulph of *Kiel*, I. §§ 332, 339, 340, 353.

The *Wey* at *Weymouth*, II. §§ 476, 560, 565, 566, 571.

The *Avon* at *Bristol*, II. §§ 713—719.

The *Ex* in its gulph, II. §§ 754, 755, 772, 776.

The *Sid* at *Sidmouth*, II. §§ 767, 768.

The *Teign* in its gulph, II. §§ 779—782.

The *Dart* in its gulph, II. §§ 813—820, 822—824; III. §§ 1027—1030.

The *Aven* in its gulph, II. §§ 839, 840:

The *Erme* in its gulph, II. §§ 847, 848.

The *Yealm* in its gulph, II. § 851:

The *Tamer* and the *Plym* in the gulph of *Plymouth*, II. §§ 854—857, 860, 862; 863, 867—869, 872—876, 878. III. § 1087.



- The *Ar* in its gulph, III. §§ 983—985, 987, 992.  
 The *Otter* in its gulph, III. §§ 1002—1005.  
 The *Camel* in the gulph of *Podstow*, III. §§ 1110, 1111, 1113.  
 The *Fal* in the gulph of *Falmouth*, III. 1131, 1134—1141, 1268,  
 1270  
 The *Heyl* in its gulph, III. §§ 1216—1219.  
 The *Hel* in its gulph, III. § 1260.  
 The *Par* in the æstuary of *St. Blazey*, III. §§ 1294, 1295.  
 The *Fowey* in its gulph, III. §§ 1298, 1300, 1302.  
 The *East* and *West Looe* in their æstuaries, III. § 1303.

—◆—

*Instances of GULPHS converted into Lakes of Fresh Water:*

- Slapton lee*, II. §§ 810, 811.  
*Pool at South Hewish*, II. § 836.  
*Loe pool*, II. §§ 1237, 1239—1241.

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HEAD XV.

“The appearance of the sides of *Vallies*, and of their *Summits*,  
 “leaves no doubt with respect to the origin of all great  
 “*sinuosities* in the surface of our Continents.”

—◆—

SECTIONS of STRATA variously INCLINED, DESCRIBED

- On the side of a hill near *Grcmsmühl*, I. §§ 319, 321.  
 In terraces on the sides of hills near *Bridport* II. §§ 535, 540,  
 559.  
 On hills in the Isle of *Wight*, II. §§ 619, 623.  
 ——— in the Isle of *Parbeck*, II. § 657.  
 In terraces on the sides of hills near *Weymouth*, II. § 685.  
 On hills near *Bath*, II. §§ 692—699, 740—747, 934.

On hills near *Bristol*, II. §§ 707—712, 716, 718, 719, 726, 727.

On the sides of combes opening into the gulph of the *Dart*, II. §§ 815, 817. III. §§ 1021—1024.

————— between *Muddicomb* and *Oriston*, II. § 851.

————— of the valley of the *Tamer*, II. § 868.

————— of the *Chedder cliffs*, II §§ 912, 913, 917.

On the northern slope of the *Mendip hills*, II. §. 923.

On one side of the valley of the *Ax*, III. § 940.

On the sides of combes near *Truro*, III. § 1128.

————— of a combe near *Mcragizey*, III. § 1275.

————— of a hill near *Nettlecombe*, III. § 1362.

————— of a valley in the *Mendip hills*, III. § 1376.

————— of combes in the *Mendip hills*, III. § 1412.

#### Signs of the FRACTURES, ANGULAR MOTIONS, and SUBSIDENCES of the Strata appear

In the mass of *soft strata* of a hill near *Travemünde*, I. § 298.

In the irregular hills and their intervals around the lakes of *Keller* and *Ploen*, I. §§ 314—321.

In the plains between *Sleswigh* and *Kiel*, I. §§ 378—380.

In the vale of the *Char*, II. § 556.

In the rocky slope of *Kingsdown* towards *Warley*, II. § 735.

In a combe in *Babicomb bay*, II. § 795.

In a deep cleft in the strata near that bay, II. § 802.

————— near the *Bolt head*, II. §§ 829, 830.

In the *Chedder cliffs*, II. §§ 908, 912, 914—918.

In the valley of *Wells*, II. § 933.

In the combes of the *Blackdown hills*, III. §§ 947, 948, 1394.

Near *Buckfastleigh*, III. §§ 1032—1036.

Near *Buckland*, III. §§ 1046, 1050.

Near *Lidford*, III. §§ 1081—1084.

In the valley of the *Tamer*, III. §§ 1086, 1087.

In a combe near *Roscarrock*, III. §§ 1098, 1099.

In the low soil between *Mount's bay* and *St. Ives bay*, III. § 1193.

At the foot of *Tregonning* and *Godolphin hills*, III. § 1236.

In combes opening into the gulph of the *Hel*, III. § 1260.

Around a hill near *St. Austle*, III. § 1287.

In the defile in which the *Fowey* flows, III. § 1298.

On the course of the *Ex*, III. §§ 1326, 1329, 1341.

Around two insulated hills of breccia near *Wiveliscombe*, III. §§ 1352, 1353.

In a valley of the *Mendip hills*, III. § 1376.

In a low space near *Somerton*, III. § 1399.

————— near *Wincaunton*, III. § 1402.

—◆—

*The unequal descent of the masses of Strata shewn by the SUMMITS of those which, having sunk the least, appear above the general level.*

On a promontory near *Torquay*, II. § 799.

On the *Bolt head* and in its combes, II. §§ 830, 831.

On *Roborough downs*, II. § 869.

On the *Mendip hills*, II. §§ 919, 920.

In the valley of the *Tone*, III. § 1349.

Covered with soft strata and forming hillocks in the vale of the *Char*, II. §§ 544, 555, 556.

————— at *Stidcombe*, III. § 986.

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## HEAD XVI.

“ First consideration respecting the *Blocks* and *Gravels*, in opposition to the idea of their having been brought down from *Mountains*, resulting from their Nature.”

—◆—

*Blocks of granite* and fragments of *flint* in a *sandy soil* near *Berlin*, I. § 135

*Block*

*Blocks of granite* on calcareous strata in the Isle of Rugen and the neighbouring islands, I. §§ 280, 281.

Difference between the *granite* of the blocks on the shores of the Baltic, and that of the mountains of Silesia, I. § 283.

*Blocks of granite* mixed with siliceous gravel in soft strata near Husum, I. §§ 383, 422.

————— on various primordial strata of a different nature on Dartmoor, II. §§ 783, 789, 863, 865. III. §§ 1041, 1073, 1080, 1332.

————— on high grounds in Cornwall consisting of strata of grey wacke, III. § 1088.

Difference between the rocks and blocks of granite on a hill near St. Columb, III. § 1127.

*Blocks of granite* on grey wacke at Ivybridge, III. § 1320.

————— on schistose hills separated by a deep vale from the eminences of Dartmoor, III. § 1323.

*Blocks of granulated quartz* on chalk, on Marlborough downs and the neighbouring country, II. §§ 688—690. III. § 1415.

*Gravel of granulated quartz* on sandy strata in Worcestershire, III. §§ 1387—1390.

Difference between the mass of *Rotter rock*, and the blocks scattered on its slope, III. § 1058.

Sudden transition, near the Lizard point, from masses of quartz scattered on schistus, to blocks and gravel of serpentine on clay, III. §§ 1245, 1246.

*Siliceous gravel* on foliated clay near Abbotsbury, II. § 516.

Fragments of flint on sandy soils near Charmouth, II. §§ 543, 544, 554—556.

*Siliceous gravel* on sandy and argillaceous strata in the Isle of Wight, II. §§ 619—621, 635, 637.

————— on sandy strata in Berkshire, III. §§ 1407, 1408, 1416.

*Blocks of sand-stone* on chalk hills near Dorchester, II. § 528.

*Strata of SAND on STONY Hills.*

On the *Mendips*, II. § 919,  
 On the *Botter rock*, III. § 1058.

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 HEAD XVII.

“ Second consideration respecting the *Blocks* and *Gravels*, re-  
 sulting from their *situations*; by which is excluded every  
 idea of their *migration* from any place on the existing  
 “ *Continents*.”

*Examples of the situations and irregular distribution of BLOCKS.*

Extraordinary accumulation of *blocks* of various kinds near  
*Liepen*, I. §§ 190 a—192.

---

of *granite* near *Warnemunde*, I. §§ 231, 241.

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at *Lambrechts-  
 aagen*, I. § 253.

*Blocks* irregularly scattered on the hills above *Zierke-see*, I.  
 §§ 177, 186.

---

near *Gremsmühl*, I. §§ 316, 322.

---

near *Gettorp*, I. § 358.

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near *Husum*, I. §§ 380, 383, 422,  
 426, 427.

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on *Dartmoor*, II. §§ 783, 784,  
 788, 789, 863—866. III. §§ 1038, 1072, 1074.

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near the *Land's end*, III. §§ 1175,  
 1176, 1183, 1185.

The

The *Logan-stone*, III. §§ 1187—1190.

Masses of *granulated quartz* which compose *Stonehenge*, III. §§ 1405, 1406.

Blocks buried in peat near *Cummeroische-see*, I. §§ 199—201.

————— near *Sleswich*, I. § 368.

————— of extraordinary size in the loose soil near *Eutin*, I. §§ 307, 310.

Abundance of *blocks* in the loose soil of the hills near *Beckey fall*, III. §§ 1334—1336.

*Of the variety of their genera and species in the same spots.*

In the stones of the *Heilige Damm*, I. §§ 250—252.

In the *blocks*, between *Rostock* and *Wismar*, I. § 255.

————— near *Emkendorff*, I. § 345.

————— on hills above the *Tamer*, II. § 864.

————— on two neighbouring eminences on *Dartmoor*, III. § 1041.

————— on the bed of the *Dart*, III. § 1049.

*Of BLOCKS and GRAVELS of the same SPECIES found together in the same spots.*

*Blocks and gravel of granite* in the *Danish Islands*, I, § 429.

————— in the islands off the coast of *Sleswich*, I. § 431.

————— of *serpentine* near the *Lizard point*, III. § 1246.

Large masses and gravel of *quartz* on the hills bordering the *Fowey*, III. § 1303.

*Of masses, some ANGULAR, and some ROUNDED.*

In beds of gravel in the cliffs at *Budleigh Salterton*, III. § 1007.

Of

*Of SAND, evidently not the product of TRITURATION.*  
*In Brandenburg, I. § 138.*

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*Of BLOCKS in CLIFFS, and in the SEA at their foot.*

*At Dobberan, I. §§ 245—247.*  
*In the island of Poel, I. §§ 266—269, 271.*  
*Near Wohlenberg, I. § 287.*  
*Near Travemünde, I. § 295.*  
*Near Kiel, I. §§ 325, 327 a, 330, 334, 337, 338.*

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*Of insulated MASSES of STRATA imbedded in RUBBISH or  
 LOOSE SOILS:*

*Of granite in growan, near St. Columb, III. §§ 1121—1123,  
 1126.*  
 ——— in granitic rubbish, in Tregonning hill, III. §§ 1212,  
 1213.  
*Of schistus in schistose rubbish, in the hills of Roscarrock, III.  
 § 1107.*  
*Of iron-stone in schistose rubbish, near Catchfrench, III. §  
 1314.*  
*Of white lime-stone in loamy strata, at Offwell, Widworthy, and  
 Membury, III. §§ 970—973, 977.*  
*Of a hard lime-stone in red strata, near Nettlecombe, III. §  
 1363.*  
*Of chalk in sand, in Berkshire, III. §§ 1408, 1417.*

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*Of BRECCIAS.*

*In the isle of Wight, II. § 600.*  
*In hills near Sidmouth, II. §§ 764, 769.*  
 ——— bordering Babicomb bay, II. §§ 794, 795, 798. III. §  
 1325.

In

- In hills bordering *Bigbury bay*, II. § 835.  
 In the *Mendip hills*, II. § 906. III. § 1376.  
 In the cliffs at *Dawlish*, III. § 1015.  
 ——— at *Teignmouth*, III. § 1017.  
 ——— at *Shuldon*, III. §§ 1019, 1020.  
 Forming part of a load in a tin-mine, III. § 1221.  
 In the cliffs of *Gerrans bay*, III. § 1273.  
 Near *Exminster*, III. § 1326.  
 Near *Exeter*, III. § 1342.  
 Near *Wiveliscombe*, III. §§ 1351—1353.  
 In hills near the *Quantocks*, III. §§ 1364, 1365.  
 Near *Birmingham*, III. §§ 1387, 1390—1392.

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## HEAD XVIII.

- “ Effects of the *Sea* on those *Coasts*, which at the birth of  
 “ the *Continents*, extended towards it with a gentle de-  
 “ clivity.”

### *Examples of the difference*

- Between the operations of the *flowing* and those of the *ebbing*  
*tides*, I. § 451. II. § 894. III. § 1110.

*That the extension of such Coasts by NEW LANDS is every where  
 at an end when, the SEDIMENTS of the LAND-WATERS no  
 longer reaching their extremity, the SEA impels against them  
 nothing but the SAND or GRAVEL covering its own bed,  
 shown in*

- The *dunes* terminating *new lands* at *Warnomünde*, I. §§ 233,  
 234, 237, 238.

•The



The dunes terminating *new lands* of the peninsula of *Darfa*, I. § 274.

\_\_\_\_\_ of the islands of *Usedom* and *Wollin*, I. § 277.

\_\_\_\_\_ of the island of *Rugen*, I. § 279.

\_\_\_\_\_ on the coast of *Sleswig* and the neighbouring islands, I. §§ 396—398, 431, 450.

\_\_\_\_\_ terminating a *strand* near *Weymouth*; II. § 491.

\_\_\_\_\_ terminating *new lands* in the gulph of *Poole*, II. §§ 671, 672.

\_\_\_\_\_ at *Exmouth*, II. §§ 772, 773, 776, 778.

\_\_\_\_\_ at *Avenmouth*, II. § 840.

\_\_\_\_\_ at *Ernemouth*, II. § 848.

\_\_\_\_\_ filling up the ancient bay of *Bridgewater*, II. §§ 890, 897. III. § 1375.

\_\_\_\_\_ overwhelming the *new lands* in the gulph of the *Camel*, III. §§ 1114, 1117.

\_\_\_\_\_ in *St. Ives bay*, III. §§ 1218, 1219.

The *Fens* of *Somersetshire* chiefly composed of *sea-sand*, II. § 903. III. § 1377.

A *strand* terminating *new lands* in the isle of *Wight*, II. § 637.

\_\_\_\_\_ terminating *meadows* at *Paington*, II. § 803.

A *strand* and *beach* in *Mounts bay*, III. §§ 1164, 1167.

A *beach* terminating *new lands* round the bay of *Wismar*, I. § 286.

\_\_\_\_\_ near *Bridport*, II. §§ 531, 532.

\_\_\_\_\_ near the *New Passage* to *Wales*, II. §§ 722, 723.

\_\_\_\_\_ near *Salcomb*, II. § 829.

\_\_\_\_\_ in the æstuary of the *Par*, III. § 1294.

\_\_\_\_\_ terminating the *meadows* of the *Seaton*, III. § 1306.

The *Heilige Damm* raised by the waves at *Dobberan*, I. §§ 244, 246, 248—252.

Remarkable

Remarkable limit of the actions of the *sea* and *land-waters* in the gulph of *Falmouth*, III. § 1140.

Remarkable limit of the actions of the *sea* and *land-waters* in *St. Ives bay*, III. § 1217.

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*Effects of the SEA on SUBMARINE BARS sloping down on one side under the water.*

The *Chesil bank*, II. §§ 479, 493—496, 502—511, 514, 521—523, 536, 538—542.

A *beach* and *strand* near *Weymouth*, II. §§ 562—564, 575, 577, 579—581.

A *beach* extending from *Christchurch* to *Hurst Castle*, II. § 604.

A slip of land at *Teignmouth* covered with *sea-sand* and *gravel*, II. § 780.

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*Examples of NEW LANDS, formed on sloping Shores, which have slipped forward under the water.*

On the coast of *Torbay*, II. § 802.

In the *peat-moors* of *Somersetshire*, II. § 902. III. §§ 1371, 1372.

In *Mounts bay*, III. § 1167.

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## HEAD XIX.

“General considerations on steep Coasts.”

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VARIETIES, FRACTURES, and INCLINATIONS of the STRATA, with evident signs that the present BED of the SEA has been produced by their SUBSIDENCE, described

In *cliffs* near *Travemünde*, I. §§ 295, 298.

— near *Kiel*, I. §§ 326, 328.

— on the coasts of *Suffolk* and *Essex*, II. §§ 454—464.

In

- In *cliffs* near *Weymouth*, II. §§ 483—491, 568; 578—587.  
 ——— on the coast of *Portland Island*, II. §§ 495, 496, 500—502.  
 ——— near *Bridport*, II. §§ 533, 534, 540, 541.  
 ——— between *Charmouth* and *Lyme*, II. §§ 546, 550, 553—555.  
 ——— between *Christchurch* and *Lymington*, II. §§ 596, 597, 599.  
 ——— on the coast of the isle of *Wight*, II. §§ 600, 612, 614, 616, 626—633.  
 ——— of the eastern part of *Dorsetshire*, II. §§ 648—650.  
 ——— of *Purbeck Island*; II. §§ 651—654, 656, 687.  
 ——— near *Sidmouth*, II. §§ 762—765, 769. III. § 999.  
 ——— at *Exmouth*, II. §§ 772—776.  
 ——— at *Teignmouth*, II. § 781. III. §§ 1017—1020.  
 ——— around *Babicomb bay*, II. §§ 794, 796—799.  
 ——— at *Torquoy*, II. §§ 801, 802.  
 ——— of *Bolt head* and *Bolt tail*, II. §§ 829—832.  
 ——— in *Bigbury bay*, II. §§ 834, 835.  
 ——— near *Seaton*, III. §§ 988—990, 996—998.  
 ——— near *Budleigh Salterton*, III. §§ 1006—1009.  
 ——— at *Dawlish*, III. § 1015.  
 ——— near *Padstow*, III. § 1115.  
 ——— at the *Land's end*, III. §§ 1178—1181, 1183.  
 ——— at *Castle Trereen*, III. §§ 1185—1187, 1192.  
 ——— of *St. Michael's mount*, III. § 1208.  
 ——— of *Kinance cove*, III. §§ 1248, 1249.  
 ——— in *Gerrans bay*, III. § 1273.  
 ——— in *Pentuan bay*, III. §§ 1276—1278.  
 ——— at *Polmear*, III. § 1292.

**ROCKS and ISLANDS** formed by the masses of *Strata*, which, in the subsidence of the bed of the *Sea*, remained above the level of the latter.

**Shag rocks**, in front of *Hope's nose*, II. § 801.

*Thurlestone*

*Thurslestone rocks*, II. § 837.

*Bar isle*, II. §§ 839, 841.

Rocks and islands, with other marks of subsidence, near *Plymouth*, II. §§ 857, 859, 872, 876, 878—880.

Islands in the ancient bay of *Bridgewater*, and in *St. George's Channel*, II. §§ 888, 898—901.

Hillock in the beach at *Seaton*, III. § 993.

*Granary*, near *Budleigh Salterton*, III. § 1004.

Rocks and islands near the *Land's end*, III. §§ 1182, 1183.

—— in *Pentuan bay*, III. §§ 1277, 1278.

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## HEAD XX.

“ *Effects of the Sea on Cliffs composed of soft Strata.*”

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*That these effects consist chiefly in diluting and washing away the fallen materials, till the Gravel or stony masses contained in the soft Strata accumulate at the foot of the Cliffs, and form a STRAND or BEACH, which secures them against the future attacks of the waves, exemplified in the CLIFFS*

At *Dobberan*, I. § 246.

On the coast of the island of *Poel*, I. §§ 268, 269, 271.

Near *Wohlenberg*, I. § 287.

Round the gulph of *Kiel*, I. §§ 325—328, 330, 334, 338, 339.

Near *Eckrenförde*, I. §§ 360, 364.

On the coasts of *Suffolk* and *Essex*, II. §§ 454, 456, 457, 459—464.

Near *Weymouth*, II. §§ 489, 582.

Near *Bridport*, II. §§ 534, 539.

Near

Near *Lyme*, II. §§ 542, 550—552. III. §§ 990, 991.

Near *Christchurch*, II. §§ 596, 597.

At *Lymington*, II. § 601.

In the isle of *Wight*, II. §§ 616, 627.

At *Budleigh Salterton*, III. §§ 1007, 1009.



## HEAD XXI.

“ Effects of the Sea on steep Coasts composed of *Stony Strata.*”



### *Depth of the Sea at the foot of the CLIFFS*

Of *Portland Island*, II §§ 496, 501.

Of the eastern part of the coast of *Dorsetshire*, II. § 650.

Of the isle of *Purbeck*, II. § 656.

Of *Rame head*, II. §§ 877, 878.

Between *Port Quin* and *Port Isaac*, III. § 1100.

Of the *Land's end*, III. §§ 1178, 1179.

Of *Castle Trereen*, III. § 1185.

Of *Kinance cove*, where extraordinary actions of the sea are described, III. §§ 1249—1256.



*That ROCKS are not worn by the actions of the Sea, is proved by the FUCI, BARNACLES, and LIMPETS, with which they are covered,*

In the estuary of the *Avon*, II. § 719.

In *Kinance cove*, III. § 1256.

Near *Fowey*, III. §§ 1301, 1302.

*That*

*That when HARD ROCKS are much shattered, the materials falling from them at last accumulate at their foot, is shewn*

In the isle of *Wight*, II. §§ 626—633.

In *Hope cove*, II. § 834.

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## HEAD XXII.

“ Effects of the Sea in *Gulphs*.”

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*These effects are shewn to consist, not in forming GULPHS, but in filling them up,*

In the gulph of *Rostoch*, I. §§ 226, 227, 232, 237.

————— of *Wismar*, I. § 258.

In a gulph in the island of *Poel*, I. § 266.

In the gulph of *Lubeck*, I. §§ 289, 292—294, 299, 300.

————— of *Kiel*, I. §§ 324, 329, 330, 332, 338, 339, 342,  
353

————— of *Eckrenförde*, I. §§ 361, 364 a.

————— of *Sleswigh*, I. §§ 369—372.

In the *Backwater* at *Weymouth*, II. §§ 476, 560, 565, 566,  
569, 570.

In the æstuary within the *Chesil bank*, II. § 514.

In a filled up gulph near *Bridport*, II. § 531.

————— near *Charmouth*, II. §§ 545, 546, 555.

————— near *Weymouth*, II. §§ 575—577.

In the gulph of *Christchurch*, II. § 595

In the haven of *Lymington*, II. §§ 601—603.

In æstuaries in the isle of *Wight*, II. §§ 610, 620, 635—640.

In the gulph of *Southampton*, II. §§ 641, 642.

In *Sandwich bay*, II. § 654.

In the gulph of *Poole*, II. §§ 670—674, 676,

- In the æstuary of the *Avon*, II. § 715.  
 In the gulph of the *Ex*, II. §§ 754—756, 758, 760, 772, 773, 776—778. III. §§ 1010, 1326.  
 ————— of *Teignmouth*, II. 779—782. III. § 1018.  
 ————— of *Dartmouth*, II. §§ 812, 815, 816, 818, 819.  
 ————— of *Portlemouth*, II. §§ 826—829.  
 ————— of the *Aven*, II. §§ 839—841.  
 ————— of the *Erme*, II. §§ 845—848.  
 ————— of the *Yealm*, II. §§ 850, 851.  
 ————— of *Plymouth*, II. §§ 854—857, 859, 860, 872—874, 878.  
 ————— of the *Ar*, III. §§ 985, 992—994.  
 ————— of the *Otter*, III. §§ 1001, 1003.  
 ————— of *Dawlish*, III. §§ 1011, 1014.  
 ————— of the *Camel*, III. §§ 1110—1118.  
 ————— of *Falmouth*, III. §§ 1130—1141, 1265, 1268.  
 ————— of the *Heyl*, III. §§ 1216—1219.  
 ————— of the *Hel*, III. §§ 1260.  
 In the æstuary of *St. Blazey*, III. §§ 1293—1295.  
 In the gulph of the *Fowey*, III. §§ 1300, 1302.  
 In the æstuaries of the *East and West Looe*, III. § 1300.  
 In the æstuary of the *Seuton*, III. § 1306.  
 ————— of the *Tidi*, III. §§ 1315, 1316.  
 ————— of the *Lynheer*, III. §§ 1316, 1317.

◆

*The only GULPHS, or properly COVES, formed by the actions of the Sea, are really the effect of previous catastrophes, which had rent the stony strata, and afterwards filled up these rents with rubbish, thus converting them into a kind of LOADS; the sections of which being in the Cliffs formed by the subsidence whence resulted the new bed of the Sea, the actions of the latter have occasioned the rubbish to crumble down, and have in this manner produced vacancies proportional to the breadth of the rents. Examples of this case are seen*

In the gulph of *Padstow*, III. § 1115.

In the gulph of *Penzance*, III. §§ 1171, 1172.

At the *Land's end*, III. § 1181.

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## HEAD XXIII.

“ General considerations on the Phenomena which prove the  
“ *small Antiquity of our CONTINENTS.*”

*Time* shewn to be a vain resource for hypotheses in their own nature impossible, III. §§ 1391, 1392.

Formation of *granite* the first operation of physical causes on our globe to which we can ascend, III. §§ 1144—1147.

The *small antiquity* of our continents proved by the phenomena of the eastern coast of *England*, II. §§ 464, 465.

Progress of the accumulation of *vegetable earth*, on the chalk hills near *Dorchester*, not interrupted by *erosion*, II. § 527.

Chronometer resulting from the interference of men, as their wants successively increase, in the destruction of the rocks at *Week*, II. § 700.

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from the cessation of the smelting works in *Kingswood*, in consequence of the exhaustion of coals, II. § 706.

Inconveniences arising from the progress of natural causes obviated by the industry of man, III. §§ 992, 1342.

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### CHRONOMETERS formed by the progress of AGRICULTURE.

On heaths in the country of *Sleswigh*, I. §§ 366, 366 a, 377.

This progress often indicated by the *names* of places, I. § 256.

Grounds, when first brought into cultivation, require to be cleared of blocks.

Example of *blocks of granite*, in the north of *Germany*, I. §§ 141, 368.



Example of *blocks of granite*, near the *Land's end*, III. §§ 1175, 1176.

————— of *granulated quartz* on *Marlborough downs*, II. §§ 688—690. III. § 1415.

————— of *quartz* near *Helstone*, III. § 1244.

————— of *flints* on the *Blackdown hills*, III. §§ 949, 1348.

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*By the change of MARSHES into MEADOWS :*

Near *Abbotsbury*, II. § 522.

Near *Seaton*, III. §§ 985, 994.

At *Otterton*, III. § 1005.

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*Refutation of the Hypothesis of an ancient SUBSIDENCE and modern ELEVATION of Land, invented in opposition to the Chronometer deduced from the preservation of Fossil Shells in loose Strata, by the differences between some of these Fossil Shells, and those of the neighbouring shore,*

On the coast of *Suffolk*, II. §§ 467—470.

————— of *Hampshire* and the *isle of Wight*, II. §§ 596—600.

The plants, of which there are impressions in the *schistose* strata covering *coal*, no longer exist in these climates, II. § 705.

Non-descript fossil shells found near the *Hotwells*, II. §§ 710, 711.

Seeds of an unknown plant found in the *peat* in *Somersetshire*, II. § 902.

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*PEAT every where forms a Chronometer by its progress and phenomena.*

In *Mecklenburg*, where it fills up *lakes*, and covers the bottoms of *vales*, I. §§ 147, 152, 154—166, 168—170, 173, 174, 176—181, 206, 207, 214, 232, 237.

In *Sleswich*, I. §§ 365, 367, 368, 370, 383.

On the *new lands*, filling up the ancient bay of *Bridgewater*, II.

§§ 888, 889, 902. III. §§ 1371—1373, 1375.

On *Dartmoor*, III. §§ 1067, 1074—1079.

On high grounds in *Cornwall*, similar to *Dartmoor*, III. §§ 1088, 1090.

In the valley of *St. Austle*, III. § 1280.

Examples of floating *peat-mosses*, I. § 400.

Sand impregnated with *peat* near *Eutin*, I. § 312.

Sandy *peat* near *Reading*, II. § 687.

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*Chronometer* of the accumulations of SAND on the northern coast of *Cornwall*, III. §§ 1114, 1218, 1224.

The same, with other *Chronometers*, in *Egypt*, III. §§ 1224, 1225.

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In the conclusion is stated the general result of all the *Chronometers* observed in various places.

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## HEAD XXIV.

“ The accumulations of fallen Materials under the abrupt sides  
 “ of Mountains, as well in Vallies, as towards the Plains,  
 “ and those which are formed at the foot of steep Coasts,  
 “ constitute one of the most common of the classes of *Chro-*  
 “ *nometers.*”

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*Slopes of these fallen Materials described*

Against a hill near *Gremmühl*, I. §§ 319—321.

Against

- Against hills near *Bath*, II. §§ 692, 693, 699.  
 Against the sides of the *Cheddar cliffs*, II. §§ 916, 918.  
 Along the course of the *Elbe*, I. § 389.  
 From the upper part of *Portland island* down to the *Chesil bank*, II. §§ 495, 496, 503, 504.  
 Of *chalk*, in the isle of *Wight*, covering sections of the sandstone strata, II. §§ 622, 623, 625—634.  
 Against cliffs near *Beer*, III. § 997.  
 ————— at *Budleigh Salterton*, III. § 1009.  
 Formed by cliffs near *Travemünde*, I. § 294.  
 ————— at *Kiel*, I. §§ 327, 328, 330, 338.  
 ————— on the coasts of *Suffolk* and *Essex*, II. §§ 456, 462—464.  
 ————— in *Gerrans bay*, III. § 1273.

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## HEAD XXV.

“ The alluvial Lands formed by Rivers along their course constitute another class of *Chronometers*.”

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### *Increasing ALLUVIAL LANDS along the course*

- Of the *Havel*, I. §§ 137, 139—141.  
 Of the *Elbe*, I. § 388.  
 Of the *Froome*, II. § 589.  
 Of the *Avon*, II. §§ 730, 732, 737.  
 Of the *Cory*, *Yarte*, and *Ax*, III. §§ 975, 984, 985, 994.  
 Of the *Otter*, III. §§ 1002, 1005, 1345.  
 Of the *Dart*, III. 1030, 1031, 1039, 1048, 1054.  
 Of the *Tamer*, III. §§ 1086, 1087.  
 Of the *Camel*, III. §§ 1094, 1095,

- Of the *Loc*, III. § 1242.  
 Of the *Fal*, III. §§ 1269—1271.  
 Of the *Fowey*, III. § 1297.  
 Of the *Seaton*, III. § 1306.  
 Of the *Er*, III. §§ 1326—1330, 1340—1342.

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## HEAD XXVI.

“The maritime new Lands form a large class of *Chronometers*.”

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### *Description of the NEW LANDS,*

- In the gulph of *Rostock*, I. § 225.  
 Between *Wismar* and the island of *Poel*, I. § 265.  
 Around that island, I. §§ 270, 271.  
 Composing the peninsula of *Darss*, I. §§ 274, 275.  
 Composing the islands of *Usedom* and *Wollin*, and many smaller ones, I. §§ 276, 277.  
 Connecting four original isles, which thus form the island of *Rugen*, I. § 279.  
 Around other islands in the bay of the *Oder*, I. § 281.  
 In the gulph of *Kiel*, I. § 353.  
 ————— of *Eckrenfürde*, I. §§ 359—361.  
 Distinguished by the name of *marsch* on the coast of *Sleswigh*, and the neighbouring islands, I. §§ 381, 383, 384, 386—419, 421—425, 431—448, 450.  
 Added to the *Danish islands*, I. § 429.  
 On the coast of *Suffolk*, II. §§ 456, 460—464.  
 In the gulph of *Christchurch*, and forming islands, II. § 595.

In

In æstuaries near *Bristol*, II. §§ 715, 718.

Along the coast of the æstuary of the *Severn*, II. §§ 720—723.

Filling up creeks in *Bigbury bay*, II. § 836.

In the gulph of *Plymouth*, II. §§ 856—858, 860, 863, 864, 867, 873 *a*, 874. III. §§ 1317, 1318.

Filling up the ancient bay of *Bridgewater* and two neighbouring bays, II. §§ 887—898, 900—904. III. §§ 1370—1377, 1396, 1409—1411.

In the gulph of the *Az*, III. §§ 984, 985, 992—994.

————— of *Dawlish*, III. § 1014.

————— of the *Camel*, III. §§ 1110, 1111, 1113, 1114.

————— of *Falmouth*, III. §§ 1133, 1136, 1139.

In *Mount's bay*, III. §§ 1164, 1166.

In the gulph of the *Hel*, III. § 1260.

Filling up the port of *Mevagizey*, III. § 1275.

In *Pentuan bay*, III. §§ 1278—1281.

In the creek of *St. Blazey*, III. § 1294.

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## HEAD XXVII.

“ Since the *Sea* has occupied its present *Bed*, its *level* has  
“ never changed.”

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*Of this, a general proof is afforded by the HORIZONTALITY of the MARITIME NEW LANDS on the Coasts of every part of the Globe, which particularly appears in all those referred to under the preceding Head.*

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*Additional circumstances concurring in this proof are described*

In the vales of the *Penc* and the *Reckenitz*, I. § 216.

In the vale of the *Warnow*. I. § 223.

———— containing the lake of *Schwerin*, I. § 259.

In the small difference between the level of the *Baltic*, and that of the lake of *Ratzeburg*, I. § 305.

In the succession of vales between *Hottenuau* and *Tonningen*, I. §§ 356, 357.

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Miscellaneous Articles, not properly reducible under any of the foregoing Heads.

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I.

*Alternations of hard and soft Strata*, which directly disprove the hypothesis of the *induration* of the *stony Strata* by *internal heat*.

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*Examples of this are described*

Near *Weymouth*, II. §§ 484, 486, 526, 575.

In *Portland island*, II. §§ 496, 498, 502.

Near *Bridport*, II. § 534.

Between *Charmouth* and *Lyme*, II. §§ 547, 549.

In the isle of *Purbeck*, II. § 663.

Near *Bath*, II. § 695.

Near *Bristol*, II. §§ 703, 709—711, 714.

Near *Exeter*, II. § 757. III. § 1326.

In the *Blackdown hills*, III. §§ 953, 955, 956.

Near *Arminster*, III. § 981.

Near *Teignmouth*, III. § 1017.

In mines in *Cornwall*, III. §§ 1197, 1233.

In

- In *Cruglaze hill*, III. §§ 1282, 1283.  
 In the *Mendip hills*, III. § 1377.  
 Near *Birmingham*, III. § 1387.  
 Near *Wincaunton*, III. § 1402.

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 II.

*Stratification of Granite.*


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*Proved by manifest examples*

- In granitic quarries near *St. Columb*, III. §§ 1121—1126.  
 In the Cornish mines, III. §§ 1144—1149, 1232—1235.  
 In *Tregonning hill*, III. §§ 1168, 1212.  
 At the *Land's end*, III. § 1181.  
 At *Castle Trereen*, III. § 1189.

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 III.

Phenomena of *Grovan*, nearly allied to *Granite*, but not produced by a *decomposition* of that substance.

- 
- On *Dartmoor*, II. § 788. III. §§ 1048, 1054, 1062, 1071, 1334.  
 On hills in *Cornwall* similar to *Dartmoor*, III. §§ 1088—1092.  
 Near *St. Columb*, III. § 1127.  
 In the Cornish mines, III. §§ 1197, 1232—1234, 1288.  
 Near *Pearryn*, III. § 1264.

In *Cruglaze hill*, III. §§ 1282—1286.

Near *Polmear*, III. § 1289.

Near *Lostwithiel*, III. § 1296.

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*The operation called STREAMING in CORNWALL is carried on  
in loose GROWAN*

In the vale of *Carnan*, III. §§ 1147, 1266.

In combes near *Castle Trereen*, III. § 1192.

In a creek of the gulph of the *Heyl*, III. § 1217.

In the valley of *St. Austle*, III. §§ 1279—1281.

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#### IV.

*Interior disorder of the Strata shewn*

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#### *In CAVERNS.*

*Kent's Cave*, II. § 799.

In the *Chedder Cliffs*, II. §§ 909—911.

*Wookey hole*, II. §§ 925—932.

Near *Buckfastleigh*, III. §§ 1034, 1035.

In *Kinance cove*, III. §§ 1253, 1254.

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#### *In QUARRIES.*

In the isle of *Purbeck*, II. §§ 651, 657—667.

In *Antony hill*, II. §§ 740—746.

In



In *Babicomb bay*, II. §§ 795—797, 802.

Near *Arminster*, III. §§ 978—981.

Near *Buckfastleigh*, III. § 1033.

Near *St. Columb*, III. §§ 1121—1126.

In *Tregonning hill*, III. § 1212.

At *Blagden*, III. §§ 1395, 1396.

Whetstone pits in the *Blackdown hills*, III. §§ 953—957.

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IN COAL-PITS.

Between *Bristol* and *Bath*, II. §§ 701—705, 728.

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IN MINES.

*Wherry mine*, III. § 1173.

*Wheat Pink*, III. §§ 1194, 1195, 1198.

*Wheat Cock* and *Powlbarrow*, III. § 1200.

*Relistian*, III. § 1221.

*Dolcoath*, III. §§ 1226—1235.

*Cruglaze*, III. §§ 1282—1286, 1288.

*Polgooth*, III. § 1287.

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In all Fractures attended with UNEQUAL SUBSIDENCES of the  
STRATA on their opposite sides

In a cliff near *Bridport*, II. § 542.

———— near *Charmouth*, II. §§ 549, 55

———— near *Exmouth*, II. § 775.

- In cliffs at *Budleigh Salterton*, III. § 1006.  
 In cliffs near *Teignmouth*, III. § 1018.  
 In a hill at *Exeter*, III. § 1326.

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 V.
Phenomena of *Veins*.

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- Mineral veins near *Plymouth*, II. §§ 859, 865, 870.  
 ————— in *Dartmoor*, III. §§ 1052, 1053.  
 ————— near *Truroc*, III. § 1148.  
 ————— near *Penzance*, III. §§ 1173, 1221.  
 ————— on the opposite sides of the low space between  
*Mount's bay*, and *St. Ives bay*, III. §§ 1194—1202.  
 ————— in *Dolcoath mine*, and several others sunk on  
 the same load, III. §§ 1226—1235.  
 ————— near *St. Austle*, III. §§ 1287, 1288.  
 General account of the Cornish mines, III. §§ 1151—  
 1162.  
 Veins of *quartz* and *schistus*, from *Bolt head* to *Bolt tail*, II.  
 § 830.  
 ————— near *Padstow*, III. § 1111.  
 ————— in *growan* in *Moreton Hampstead* hill, III. §  
 1071.  
 ————— in *granite* at *Castle Trereen*, III. § 1191.  
 Veins of *quartz* and *pseudo-granite* passing through *granite*  
 as well as *schistus*, in *St. Michael's mount*, III. §§ 1205—  
 1207.  
 ————— in *Tregonning hill*, III. § 1214.  
 Vein of *iron-stone* in *schistus*, near *Liskeard*, III. § 1304.

## VI.

## Meteorological Phenomena.

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Observed near *Dobberan*, I. §§ 241 *a*, 242.  
———— on hills in *Cornwall*, III. § 1091.  
———— from *Dartmoor*, III. § 1338.

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